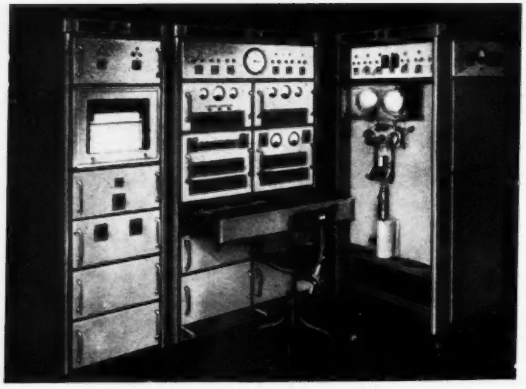
AP

DISCOVERY

MAY 1956
2/6

The MS2 Mass Spectrometer



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Enriched Mass 115	0·70	0·37	11·2	35·8	10·3	19·0	15·0	6·2	0·81	0·65
117	0·56	0·16	0·47	3·2	**69·9**	14·0	2·7	2·9	5·7	0·44
118	0·22	<0·04	<0·04	0·25	0·93	**94·1**	2·95	1·36	0·08	0·10
119	0·33	0·11	<0·04	0·49	0·72	18·5	**71·7**	7·3	0·67	0·22
122	0·20	0·34	0·34	2·1	8·7	5·1	2·6	3·4	**75·3**	1·95

The table illustrates the application of the MS2 to Isotope assay work. Samples of stannic chloride enriched by electro-magnetic separation, were analysed and compared with a normal sample. The figures in bold type are the final amounts of the particular isotopes in which the samples were enriched.

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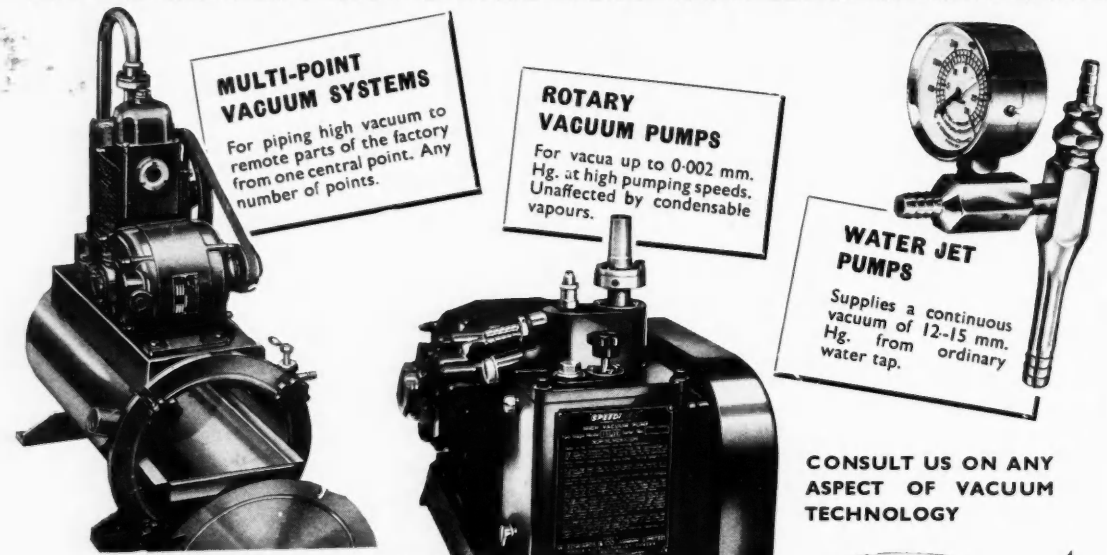

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MAY 1956 VOLUME XVII NUMBER 5

CONTENTS

THE PROGRESS OF SCIENCE 177
- The Minister of Education Replies
- The Solar Flare
- The Science of Science
- An Electronic Watch

SIGMUND FREUD: 1856–1939 181
Aubrey Lewis

THE NEW IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY 184

PHOTOGRAPHING THE INVISIBLE 186

THE ZOOLOGICAL STATION AT NAPLES 187
Prof. C. M. Yonge, C.B.E., F.R.S.

A HUNDRED YEARS OF SYNTHETIC DYESTUFFS 189
E. R. Ward, B.Sc., Ph.D., A.R.I.C.

AUTOMATION: NEW TOOL OF MANAGERS 193
Sir Walter Puckey

INDUSTRIAL GAS TURBINES 197
Leo Walter

ARTIFICIAL INSEMINATION AND DOG BREEDING 203
A. E. Harrop, M.R.C.V.S.

THE INTERNATIONAL GEOPHYSICAL YEAR MONTH BY MONTH 205

THE BOOKSHELF 208

FAR AND NEAR 215

COVER PICTURE: An aerial view of South Kensington as it will appear in the future. The new Imperial College of Science and Technology is in yellow.

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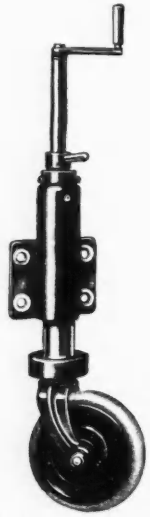

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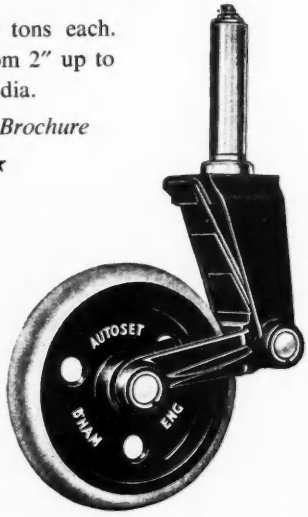

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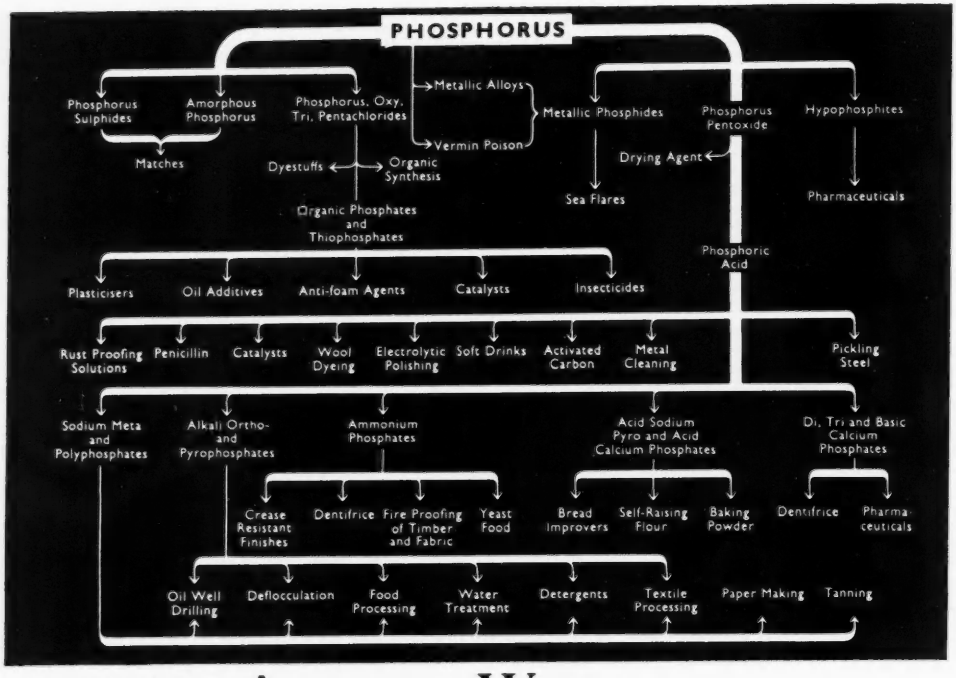

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THE PROGRESS OF SCIENCE

THE MINISTER OF EDUCATION REPLIES

Dear Mr. Editor,

A White Paper is not enough. That is the burden of your editorial on the Government's five-year plan for technical education announced at the end of February. I agree with you. We need a concerted effort from local authorities, employers and trade unions, technical colleges, schools, parents and the students themselves. In all this there is a big part for the Press to play. A publication like DISCOVERY can do a great service by keeping the public in the picture and stimulating discussion and action among the experts.

I believe we are well placed now for success. The romance of science is catching on. More of it is being taught in the schools, and, although we need more and yet better science teachers, the numbers of boys and girls specialising in science is increasing every year. Soon the post-war birthrate will be helping us. It would have been hard to get a 50% increase in technologists out of a stable population. It will be much easier to do so as the numbers rise steeply during the next ten years.

You quote some figures out of an appendix to the White Paper, and suggest that the present position is "desperate" in comparison with other countries. A closer study of the appendix will show that in the production of scientists and technologists combined in 1954 we compared well with the United States and all the countries of Western Europe. However, if the Russian figures are accurate, we are well behind the U.S.S.R., and that in itself is a spur to action. But our own circumstances demand an increase and the Government's plan represents a first instalment.

As for methods, we have undertaken to provide the necessary capital, and I am sure that the local education authorities will get the buildings built. We shall do all we can to help them, and we have already streamlined our administrative procedures for this purpose.

The teachers will be more difficult to get. There is no short cut to producing more university graduates in science or engineering, but it is up to the Burnham Committee to see that reasonable salaries are offered and to authorities to see that conditions of service are good, so that the technical colleges may attract a fair share of the graduates available. Part-time teachers have always played a large part in technical education, and industry has been readier than some critics suppose to lend people for this work. More and more firms must be persuaded that it is in their interest to do this; it is indeed essential if the instruction is to be really related to industrial needs and kept up to date.

You recommend the use of operational research techniques. These are, I think, more appropriate to training than to education, as indeed are some of your other suggestions. The general aim of technical education is not to push a given amount of knowledge into a student in the shortest possible time, but to produce men and women who will make good technologists and technicians.

The search for better and more efficient methods of teaching is one of the main functions of H.M. Inspectors, some sixty of whom are constantly on the job advising the teachers in the colleges and organising short refresher courses for teachers to make known new developments and teaching techniques.

Other research is also in progress. Your editorial mentions the National Foundation for Educational Research. This Foundation has been doing some valuable fact-finding in various fields. It has recently undertaken a preliminary inquiry into secondary technical education in all kinds of schools. This should usefully focus attention on the base of the technical pyramid.

The Central Advisory Council for England, under the chairmanship of Mr. Geoffrey Crowther, have just begun an important investigation into the education of boys and girls between fifteen and eighteen. The Council are to consider in particular the balance between general and specialised studies in both schools and technical colleges.

Lessons from abroad are always welcome, as you suggest they should be. Since the war, H.M. Inspectors have visited Canada, France, Western Germany, Holland, Sweden, Switzerland and the United States, and one will have been to Russia by the time that this letter appears in print.

Finally, I hope your readers will not under-estimate the scope and scale of the Government's plan. The building up of colleges of advanced technology will transform the provision for advanced work, and the doubling of the number of students released for part-time day courses will immensely strengthen the whole structure of technical education. It is already clear that there is much goodwill towards the plan in many quarters. With this support we can now concentrate on action.

Yours sincerely,

DAVID ECCLES.

Ministry of Education,
Curzon Street, London, W.1.
March 21st, 1956.

THE SOLAR FLARE OF FEBRUARY 23, 1956

During February two streams of large sunspots were visible in solar latitudes 20°N and 20°S, and on February 20 the total area of sunspots exceeded that on any day since 1947. There has been a steady increase of sunspots since the first half of 1954, when they were at a minimum. From November 1955 to February 1956 the mean daily sunspot number was about 90 and if the sunspot activity continues to increase it is believed that by the end of this year it will exceed 150.

On February 23, 0330 hours U.T., that is 3h 30m Universal Time or Greenwich Mean Time, a large flare on the sun was observed from Kodaikanal Observatory,

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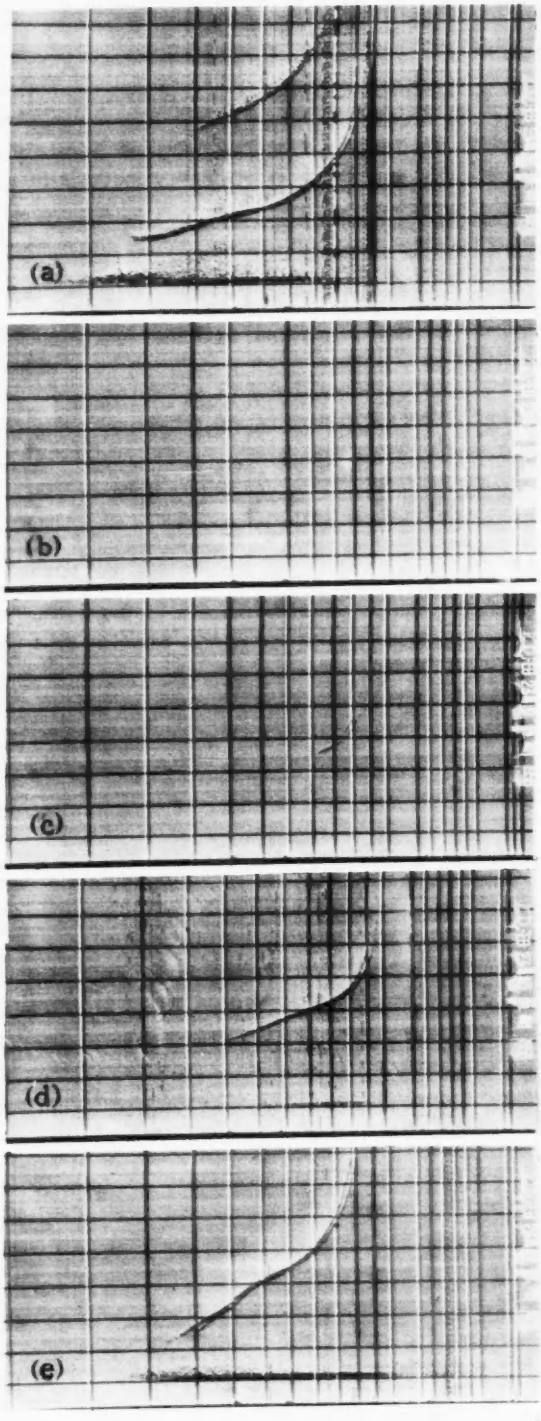
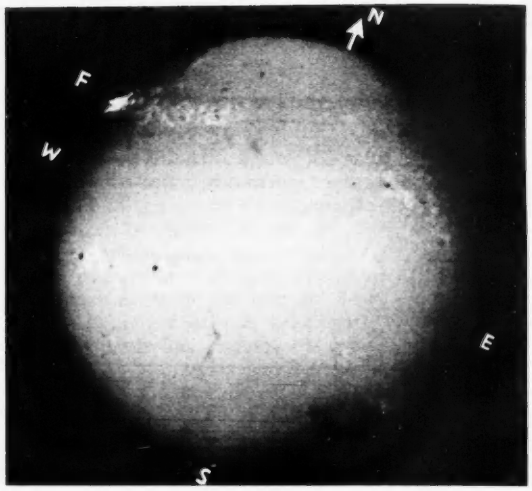
TBW/290A

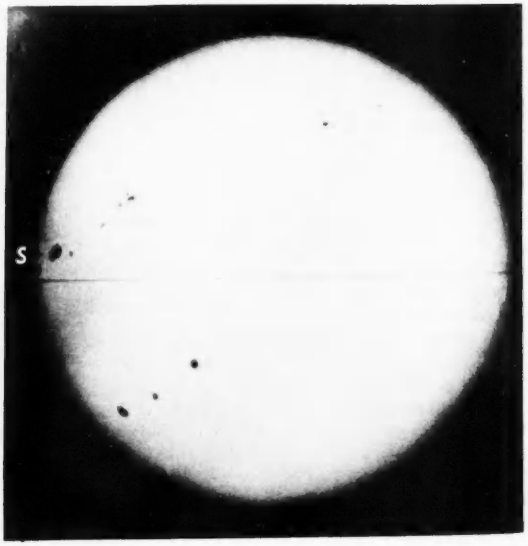


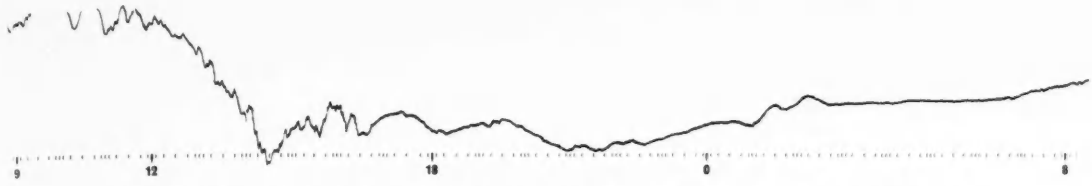


(*Left*). *Ionospheric Observations.*—(*a*) Shows undisturbed record; (*b*) shows complete fade-out; (*c*) shows beginning of recovery; (*d*) partial recovery; and (*e*) complete recovery to normal.

(*Above*). The point *F* marks the flare on the west limb of the Sun photographed in red light of hydrogen at 0400 U.T. on February 23, 1956. This photograph does not represent the maximum phase of the flare, which probably occurred between 0345 and 0355 U.T. Visual spectroscopic observations suggest that the width of the *H*-α line in the flare did not exceed 5 Å. and that of *H*-β 3·5 Å. during the life of the flare. This would put the flare in the "importance" class between 2 and 3. During the flare the *H*-β line was always narrower than the *H*-α line.

(*Below*). This photograph shows all the spots on the sun's disk on February 23, 1956. Spotgroup marked *S* was responsible for the flare.





Record of the earth's magnetic field (horizontal force) on February 25, 1956, showing a geomagnetic storm which began at 0312 U.T. The range of the storm was about 480 γ. (Times indicated in the chart are U.T., five and a half hours ahead of G.M.T.)

India, and lasted till 0510 hours, or 1h 40m. Unfortunately the cosmic ray apparatus was out of action, but newspaper reports announced an increase of about 6% in cosmic ray intensity, though there is no guarantee that the reports are quite reliable. However, the Astrophysical Observatory at Kodaikanal secured photographs giving optical, magnetic and ionospheric observations in connexion with the solar flare, details of which were sent by Dr. A. K. Das to the offices of DISCOVERY.

As usually happens in cases of solar disturbances, there was considerable difficulty with short-wave radio communication, and the following incident may be typical of others, though probably not under such poignant circumstances. On February 24 H.M. Submarine *Acheron* was reported missing in the Arctic after radio contact with her was lost. However, she returned to her base at Rothesay on March 7 and her captain stated that the telegraphist had sat for sixteen hours at his keyboard trying to make contact with the Admiralty. He was only able to receive the communications "sub-miss", and then later "sub-sunk". The crew had no anxiety about their own safety but were naturally very concerned about the distress of their relatives.

THE SCIENCE OF SCIENCE

One need not labour the point that those now concerned professionally with science and technology have more worries than are inherent in mathematics, instruments and theories. We have serious shortages of scientists and teachers of science, and yet the body of knowledge has grown so vast that inter-communication presents difficulties in coping with the literature and its gargantuan volumes of abstracts. The increase in bulk has led to intensified specialisation and narrowness, and the advent of the big machine, replacing individual apparatus in the laboratory, has wrought great change in experimental organisations. Specialist teams and individuals now fear there may be a diminution of interchange among them. Scientific education has become geared to the specialist research level, although this level absorbs only a fraction of the output.

The general disease—a sort of House That Dirac Built—is not cured by applying palliatives to the separate symptoms. At the same time any move towards a planning of science evokes an immediate and strong reaction from those who realise that undue meddling by committees and non-scientists will kill the goose that lays the golden eggs of research. Planning by the scientist may not be sufficient though, for senior scientists promoted to administration find that a lifetime's experience in one speciality is inadequate qualification for the directing of a large department including others. And who is to plan for the young scientist who must mortgage his whole career by being forced into early specialisation?

Clearly these problems connected with the growth and structure of science must be tackled, and they should be tackled professionally and scientifically. In general the working scientist, without an unusually wide and long experience in many fields, is little better than an amateur in this respect. Even the ablest scientists become amateurs when they step outside their own fields, and their pronouncements on science in general may carry little more weight than those on religious or political matters—in such things they are ordinary educated citizens.

What, then, is to be done to provide better understanding of the pressing problems of growth and structure in science? Much has already been done by discussion and deliberation through the learned societies and connected organisations, and this will, of course, continue profitably. A new development, of the greatest importance and significance because it offers possibilities of radical improvement, is the rise in level and popularity of studies in the history and philosophy of science. Some decades ago this subject might have been neglected as being fit only for second-rate minds, for retired scientists, and for those who could talk but not do. The fact that science, unlike the arts, is cumulative led many people to believe that the past of science is dead, and that history and philosophy have no relevance for the man in the laboratory. This point of view can hardly be maintained in an age when problems of growth and structure have become serious. If we know but little of the psychology of scientific discovery and cannot become prophets of the future of science, we can at least study its persistent features rather than those constantly in a state of flux. As the practical politician needs to know something of history and of political theory, the scientist needs a competent grasp of the whole field of science and its structure. This has become so complex that it no longer suffices to pick it up as one goes along—it demands (and is now receiving) careful scholarly study in its own right and with its own techniques and disciplines.

For the past five years History and Philosophy of Science has been amongst the subjects of the Natural

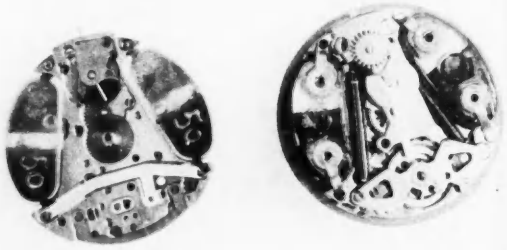
Science Tripos at Cambridge University. The subject has been in the curriculum for more than thirty years in London, and new departments are springing up in other universities in this country. These bodies are now attracting a considerable number of first-class teachers who cannot be regarded as "scientists gone wrong", any more than astronomers can be thought of as decayed mathematicians and physicists. They are, in fact, mainly younger scientists who have preferred the wider field, the virgin territory and the varied (if equally difficult) techniques of historical and philosophical inquiry to specialised research work. Judging by undergraduate response alone, the courses at Cambridge have been a great success, attracting more students than was expected and perhaps more than can be coped with in the existing organisation. An undergraduate discussion society devoted to the subject now has a membership of over 150 and is particularly active in its response to lecturers and in its critical analysis of problems.

It seems quite possible that courses like this may provide an answer to many of the current problems of manpower and specialisation. The para-scientific professions concerned with the organisation, application and teaching of science need more and better men—not failed research workers. Schools need people who can teach science not merely to intending researchers, but to non-specialists as well. Science has affected whole areas of the world almost untouched by our western religion, politics or philosophy, and humanistic teaching is sadly lacking if this fact is not borne in mind. Science itself needs some sort of liaison agents able to keep abreast of more than one speciality at a time, to help cross-fertilisation and co-ordination. The government of the nation needs people able to advise on large sections of science, as well as specialists who might not see the wood for the trees.

Would it not be better to train people specifically for such posts by more general courses, including a proper study of history and philosophy of science? We cannot rely entirely on wastage from the research front to give us the first-class teachers, administrators, advisors and co-ordinators we so urgently need. It is evident that these new university departments should be encouraged, and that some fraction of a per cent of the money spent on science should be directed towards such general courses and to the science of science itself. It is also important that government, industry and the teaching profession should look to the new learning and see whether people trained in this way might satisfy their demands for wider coverage and deeper understanding than is afforded by traditional specialist science alone.

AN ELECTRONIC WATCH

During the past six years the LIP Watch Factory in Besançon, France, has been perfecting an electronic watch containing a 2-cell battery yielding electrical energy. Each cell is about the volume of a bean, weighs 1·8 grams and yields 1 volt. There is a sub-miniature motor whose coil (40 millimetres of wire) comprising 10,000 turns, transforms the electric power into mechanical. The power of the motor is 1·5 hundred-millionth horse-power. Ten million electronic watches could be run on the power necessary for a 100-candle-power lamp. An oscillating rotor acts as regulator.



Two views of the electronic movement.

Typical electronic component parts, not normally included in a standard watch.

The electronic watch does not tick. Its pulsations (three a second) are entirely different from the tick-tack of an escapement watch.

The electronic watch is less sensible to changes in atmospheric pressure than other watches. In weight and appearance it is similar to a mechanical watch except that it has no winder. It is slightly lighter than the watches to which we are accustomed.

SIGMUND FREUD: 1856-1939

AUBREY LEWIS

Dr. Aubrey Lewis is Professor of Psychiatry in the University of London. He is in charge of the Professorial Unit at the Maudsley Hospital and is Honorary Director of a Medical Research Council Unit for Research in Social Psychiatry. He is not a psycho-analyst. He has written briefly about psycho-analysis as a science in a chapter "Medical Psychology" in "A Century of Science" (edited by Herbert Dingle, 1951).

This generation, which recognises Freud as a man of genius, is not disposed to belittle his abilities, nor to adopt without question his own modest appraisal of them: "I have very restricted capacities or talents. None at all for the natural sciences; nothing for mathematics; nothing for anything quantitative. But what I have, of a very restricted nature, was probably very intensive." With this modesty about his natural gifts, Freud combined a lofty estimate of his achievement. "I have a high opinion of what I have discovered, but not of myself." He ranked his discovery with those of Copernicus and Darwin; the passage in which he did so is notable. "Humanity has in the course of time had to endure from the hands of science two great outrages upon its naïve self-love. The first was when it realised that our earth was not the centre of the universe, but only a tiny speck in a world-system of a magnitude hardly conceivable; this is associated in our minds with the name of Copernicus, although Alexandrian doctrines taught something very similar. The second was when biological research robbed man of his peculiar privilege of having been specially created, and relegated him to a descent from the animal world, implying an ineradicable animal nature in him: this transvaluation has been accomplished in our own time upon the instigation of Charles Darwin, Wallace and their predecessors, and not without the most violent opposition from their contemporaries. But man's craving for grandiosity is now suffering the third and most bitter blow from present-day psychological research which is endeavouring to prove to the 'ego' of each one of us that he is not even master in his own house, but that he must remain content with the veriest scraps of information about what is going on unconsciously in his own mind. We psycho-analysts were neither the first nor the only ones to propose to mankind that they should look inward; but it appears to be our lot to advocate it most insistently and to support it by empirical evidence which touches every man closely. This is the kernel of the universal revolt against our science, of the total disregard of academic courtesy in dispute, and the liberation of opposition from all the constraints of impartial logic."

Since those words were written, forty years ago, men have become more ready to believe that they have an animal nature, impelling them to acts which they cannot consciously understand or wholly control. Virulent attacks on psycho-analysis, such as Freud sought to account for, are not in keeping with the temper of our day, and opposition to it has become courteous and for the most part logical. Opposition, however, there still is, on two counts: the status of psycho-analysis as a science, and its efficacy as a method of treating psychological illness.

It does not derogate from Freud's greatness as one of the most original and penetrating minds of the last hundred years, to admit that much of what he put forward is still in dispute, and that psycho-analysts have themselves modified and corrected some of his formulations. This he foresaw, since psycho-analysis was not for him a system but an ever-growing body of knowledge, founded on observation of the facts of mental life, with its "theoretical superstructure still incomplete and subject to constant alteration". "It may perhaps seem to you", he wrote to Einstein, "as though our theories are a kind of mythology and, in the present case, not even an agreeable one. But does not every science come in the end to a kind of mythology like this?"

MODERN ASSESSMENT OF FREUD

Because of the controversy which still surrounds the tenets of psycho-analysis, Freud is perhaps to be related to psychology and psychiatry more as Marx is related to economics and political theory than as Darwin is to biology or Einstein to physics. Many who deny neither the influence nor the greatness of his contribution contest its lasting truth. Others, observing its application—which covers many more fields than the medical ones of pathology and treatment from which it arose—question the wider generalisations upon which such application rests. Doubts arise chiefly because of the great difficulty of testing the findings of psycho-analysis by methods customary in science.

Friendly critics (including some psycho-analysts) have often pointed out that psycho-analysts have paid too little regard to the duty of verifying, by methods found necessary in science, the observations and theoretical conclusions of Freud and other pioneers. Freud expressed his hypotheses in the biological language of his time, with a plentiful use of metaphor and analogy. He had been influenced by men like Brentano, Hughlings Jackson, Brücke, John Stuart Mill, Meynert, Fechner and Breuer, men of the 19th century. It is inevitable that subsequent advances in many areas of knowledge will have compelled revision and restatement, such as indeed characterised Freud's own progress. Revision from within has sometimes led to divergence and defection—of which Adler and Jung were early instances, and Karen Horney a more recent one; in other cases, for example, Melanie Klein and W. R. D. Fairbairn, it has resulted in drastic changes of theory, vigorously rejected by some who regard these newer views as deviating from the fundamental principles of

SIGMUND FREUD

psycho-analysis. In such a situation it is very plain that everything must be checked not on the basis of its accordance with accepted theory but on the basis of fact. Controlled observation and experiment are inordinately difficult to apply in this territory: but some work of the kind has been done. In many details confirmatory of psycho-analytic theory as stated by Freud, it usually bears on superficial aspects, however, and leaves the fundamental issues untouched. Until experimental and other methods of verification have been applied to these basic issues, psycho-analysis will lack the full status of a science. It must in any case rank as one of the social sciences, rather than as a physical science. Quantitative precision such as the physical sciences attain is a very remote goal for the study of man's motives and emotional development: but it is well within the scope of psychology to demand, and devise, surer methods of empirical substantiation for psycho-analytic theory than have hitherto been provided by psycho-analysts. It is, however, right to remember that until Freud opened the way, psychologists had been hardly at all concerned with forces that can be held to account for the irrational in human thought and behaviour. Motivation was ignored. Psychology was largely academic, in the pejorative meaning of the word. Freud brought life and stimulus into it; his theories will occupy it for many a day to come. E. G. Boring, the historian of experimental psychology (who has himself been psycho-analysed), holds that psycho-analysis has so far been prescientific, but he sums up its importance in a confident prediction of what posterity will think of it: "It is not likely that the history of psychology can

be written in the next three centuries without mention of Freud's name and still claim to be a general history of psychology."

PSYCHOANALYSIS AND MEDICINE

It was psycho-analysis as a method of medical treatment that made it possible for Freud and those who followed him to make observations on which theory was constructed and modified. In that sense its therapeutic use was indispensable, and indeed continues to be so, for psycho-analytic inquiries into human nature. But important as psycho-analytic treatment may be to the individual patient and his doctor, it is not by its therapeutic success or failure that the true status of psycho-analysis is to be judged. This was evidently Freud's own view: "The future will probably attribute far greater importance to psycho-analysis as the science of the unconscious than as a therapeutic procedure." There is still room for honest doubt about the right indications for psycho-analytic treatment and its efficacy for particular forms of mental disorder: here, too, controlled studies are required to clarify the problem (which confronts every psychiatrist, and every citizen who believes that the National Health Service should provide every kind of treatment whose efficacy has been sufficiently proved); but the intrinsic obstacles in the way of a properly conducted assessment of these matters are so great as to have hitherto prevented any thorough and dependable inquiry.

The relation of psycho-analysis to medical practice has gone through some vicissitudes. Freud was himself a well-trained physician; he had made important contributions to pharmacology and neurology before he devoted himself to the study of neuroses. His training in the laboratories of men such as Meynert and Brücke had a profound effect on his thought, as is very plain in the correspondence he had with Wilhelm Fliess between 1887 and 1902, and in the illuminating "Project for a Scientific Psychology" which he drafted in 1895. But his mind ranged beyond the medical field to consider the motives of human behaviour in diverse forms and places: "My interest, after making a lifelong detour through the natural sciences, medicine and psychotherapy, returned to the cultural problem which had fascinated me long before, when I was a youth scarcely old enough for thinking. At the very climax of my psycho-analytic work, in 1912, I had already attempted in "Totem and Taboo" to make use of the newly discovered findings of analysis in order to investigate the origins of religion and morality. I now carried this work a stage further in two later essays, "The Future of an Illusion" (1927) and "Civilisation and its Discontents" (1930). I perceived ever more clearly that the events of human history, the interactions between human nature, cultural development and the precipitates of primeval experiences (the most prominent example of which is religion) are no more than a reflection of the dynamic conflicts between the ego, the id and the superego, which psycho-analysis studies in the individual—are the very same processes repeated upon a wider stage." This deflection of his interests was associated with a partial repudiation of medicine as the parent of psycho-analysis. In lively discussions concerning "lay analysis" Freud went so far as to say (in 1927) that "after forty-one years of medical activity, my self-knowledge tells me that I have never really been a doctor in the proper sense"; he required that doctors who wished to be psycho-analysts should "overcome the one-sidedness that is fostered by instruction in medical schools and should resist the temptation to flirt with endocrinology and the autonomic nervous system". Though this was his later view, perhaps the truer expression of his thought was in a letter to Ernest Jones in 1911, in which he wrote, "We are to withstand the big temptation to settle down in our colonies, where we cannot but be strangers, distinguished visitors, and have to revert every time to our native country in Medicine, where we find the root of our powers."

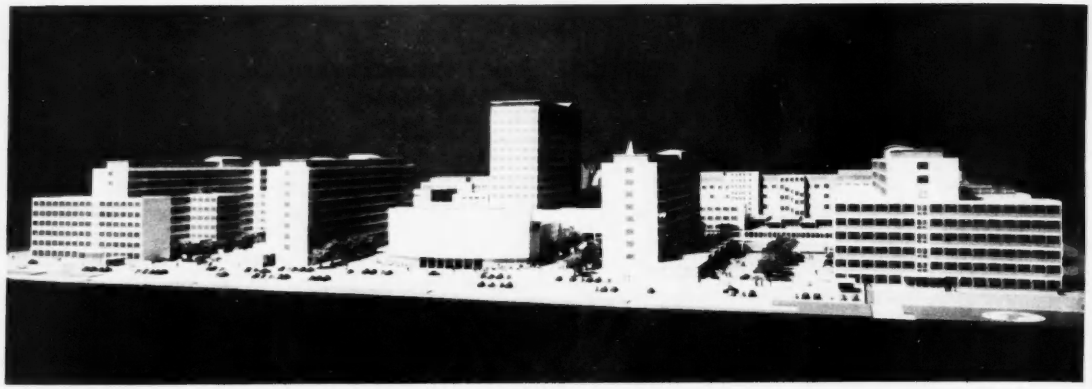
FREUD, THE MAN

Freud's personal life was so interwoven with his work that separate consideration of it is impossible: "psycho-analysis came to be the whole content of my life . . . no personal experiences of mine are of any interest in comparison to my relations with that science", His personal qualities, set out by a faithful biographer, reveal a man of consummate integrity and courage, blameless in his domestic life, immensely industrious, and a leader who collected around him men of ability. He bore contumely, defections, painful disease, and exile with resolute dignity. Some of the distressing experiences of his earlier years probably influenced his outlook and character. Thus he attributed his firmness against opposition and his independence of judgment to the foundation laid when he entered the University of Vienna and found that he was expected to feel inferior and an alien because he was a Jew: "at an early age I was made familiar with the fate of being in the Opposition and of being put under the ban of the compact majority". There were complexities in his character and in his human relations: without them he could not have been the man he was. But transcending them was the overmastering passion to get at the truth about human nature: this passion went with a fundamental simplicity and directness, in paradoxical contrast to the intricacy and subtlety of the problems he grappled with all his life. No one conversant with his achievement and with the information Dr. Ernest Jones has made available about him could withhold respect or deny greatness to this outstanding man.

FOR FURTHER READING

The three volumes of the *Life of Freud* by Ernest Jones are being published by the Hogarth Press. Vol 1, "The Young Freud", appeared in 1953, followed in 1955 by "The Years of Maturity". There is no date announced for the final volume.

Hogarth Press are also publishing a standard edition of the complete psychological works of Freud in 24 volumes, eight of which have so far appeared. The complete set is sold at £36, and orders will not be accepted for single volumes.

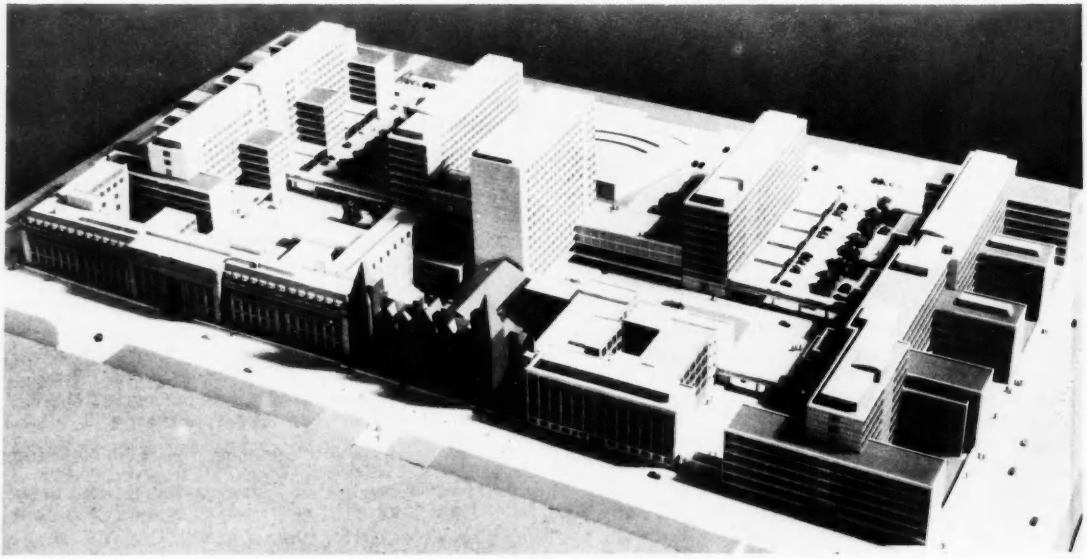


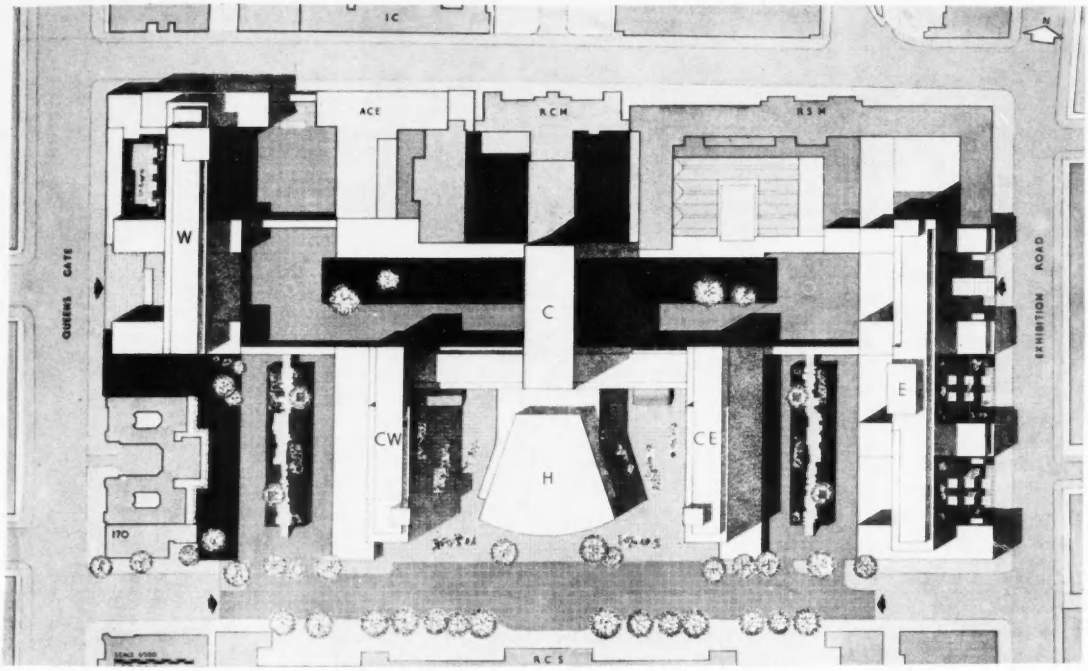
THE NEW IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

The yearly output of graduate engineers is at present 60,000 in the Soviet Union, 22,000 in the United States and 3000 in Great Britain. The Imperial College of Science and Technology in South Kensington has now 2000 students, 1300 of whom are studying some form of technology, mainly engineering. If we are not to lag technologically behind other countries the output of students must be increased, and in 1953 the Government asked the College to increase its numbers from 1650 to 3000 by 1962. New premises are therefore urgently needed, and the College was offered the "island site" formed by the four roads, Prince Consort Road, Exhibition Road, Queen's Gate and Imperial Institute Road.

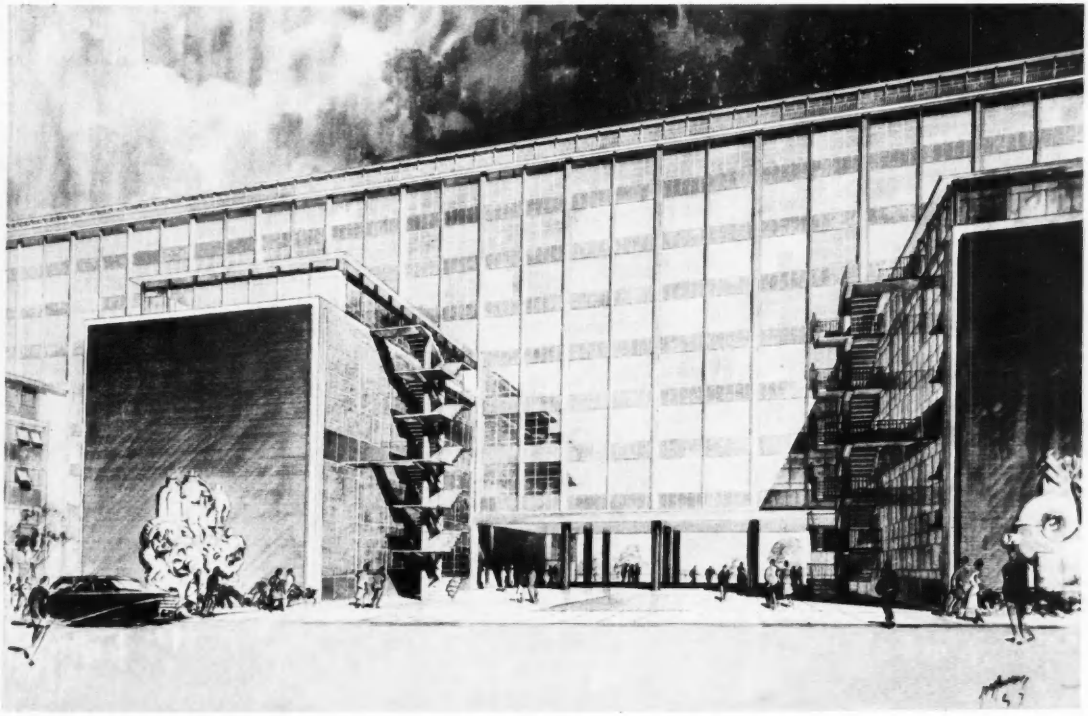
In 1953 the College drew up a plan for its expansion. It was calculated that the floor area needed would be a little more than 1,800,000 square feet, thus providing 500 square feet per student. This is an average figure; post-graduates take more space than undergraduates, and the College has the highest ratio of post-graduates to total students of any college in Great Britain. The large engineering departments will occupy 750,000 square feet. Science departments are to have 500,000 square feet and mining departments 175,000.

DISCOVERY's cover for this month shows a drawing of the area around the College with its new buildings as it should appear when completed. The architects are Messrs. Norman and Dawbarn. The layout is basically symmetrical, consisting of five "spine" blocks all running from north to south. Four of these blocks are to be 120 feet high. Two of these spines are set back about 80 feet from the adjoining roads to allow space for a series of lower spurs separated by gardens and





(*Above*) Plan of the new buildings. The main blocks are 120 feet high. The spines of *E* and *W* are set back some 80 feet from Exhibition Road and Queen's Gate respectively. The central block *C* is 200 feet high with low wings on either side, and, at its southern end, a Great Hall, *H*. (*Below*) One of the main entrances.



paved terraces. The central block is to be 200 feet high with low wings on either side and, at its southern end, a Great Hall. The remaining blocks are all to be devoted to teaching and research. The central block with its wings and Great Hall contains libraries, reading rooms, common-rooms and other elements which distinguish university life from that of students undergoing technical training alone.

The whole scheme is intended to provide a College of Science and Technology second to none in the world. Students will have excellent facilities for work in pleasant surroundings.

It is interesting to recall that the Prince Consort, founder and first College Resident, hoped that the area southward from Kensington Gardens would become a comprehensive centre for the arts and sciences. It was with this in mind that the Commissioners for the 1851 Exhibition bought the land with their surplus funds when they had been charged with the duty of using their resources "to increase the means of Industrial Education and extend the Influence of Science and Art upon productive industry".

Some critics have thought it would be better to move the College to the country; but by remaining in London it can retain and develop its close ties with London University and the learned and professional societies.

PHOTOGRAPHING THE INVISIBLE

A unique instrument which makes it possible to see in the dark has just been shown to the public for the first time by Baird Associates, Inc., Cambridge, Massachusetts. The device is called an evaporograph (nicknamed EVA) and enables one to spot a man 200 yards away or to see a house a mile distant in total darkness. It was originally designed for use by the armed services and depends on the basic principle of infra-red radiation. Different materials radiate varying intensities of infra-red, depending upon temperature and surface. This radiation is present at all times and can be detected from a distance of several miles.

In operation, the evaporograph is similar to a camera. The unit collects radiation emitted from an object and focuses it as an image on to an oil film. The oil then evaporates away from point to point at rates varying with the amount of radiation received at each point. Seen in reflected light, these differences in oil-film thickness appear as different colours, like oil films on water. A detailed thermal picture of the field of view is thus obtained in colour. This picture can be viewed directly, or a photographic record can be made with a camera which is incorporated in the apparatus. The unit is designed to observe radiation differences corresponding to temperature variations of one to several thousand degrees Fahrenheit. Accurate temperature measurements can be made either visually or photographically from this image.

FIG. 1. Evaporograph picture of a girl holding a glass of ice-water taken in a darkened room. The colder spots of the objects appear as brighter spots in the image.

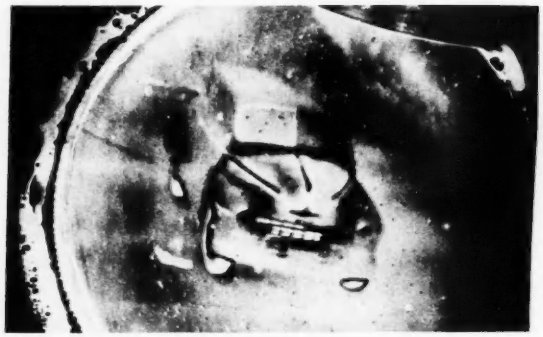


FIG. 2. Evaporograph picture of a car at night. Note hot tyres and radiator.

EVA is housed in a cabinet $18 \times 14 \times 11$ inches. The infra-red radiation enters through a lens on one side, and the operator views the oil-film image through an eye-piece on the other.

It is hoped that the evaporograph will be useful in industry and research. Simultaneous observations can be made of temperatures over the entire surface of a process vessel or an electronic chassis. It may even become possible to peer inside a radio tube or look at the heat of a flame, and to know at once the exact temperatures in all parts of the visible scene. A picture of a house in winter would reveal where heat was escaping and where insulation should be added.

The instrument may also have a medical application. The temperature differences over the surface of the human body are directly related to health. These differences can be seen in detail with the evaporograph.

The principle of operation of this instrument was first demonstrated in Germany by Dr. M. Czerny. Work at Baird Associates was originally suggested by Dr. Paul Ovrebo of the U.S. Air Force at Dayton, and has been carried on there for the past five years. Dr. Bruce Billings, vice-president of Baird Associates, was in charge of the project. Dr. David Z. Robinson of Baird participated actively in the development.

THE ZOOLOGICAL STATION AT NAPLES

PROF. C. M. YONGE, C.B.E., F.R.S.

In the year 1867 a young German zoologist named Anton Dohrn came to this country hoping to work on development in marine crustaceans. There were then no marine laboratories but, he later wrote: "Following the friendly advice of Dr. Baird of the British Museum, I went to Millport, the watering-place on the island of Great Cumbrae, in the Firth of Clyde, on the west coast of Scotland, near Glasgow." There he met David Robertson, the "Naturalist of Cumbrae", who, after making a comfortable fortune in business in Glasgow, had settled at Millport to devote himself to the study of marine biology. And with his help, Dohrn found his crustaceans.

The early dredgings of Robertson aroused the interest which led to the establishment of the now large and active laboratory of the Scottish Marine Biological Association. But without doubt Dohrn's visit to Millport strengthened, if it did not indeed originate, his idea of founding a permanent laboratory near the sea-shore where those of like interests to himself could study the structure, the development, and the habits of marine creatures. It was a pursuit which the evolutionary views of Charles Darwin, published less than ten years previously, had revealed as likely to prove of fascinating interest.

Searching for the ideal site for such a marine biological station, Dohrn visited Sicily in the following year, working in a temporary laboratory at Messina. That winter he returned to Germany and by his inspiration and drive began to interest others and to collect money for the foundation of a marine laboratory and aquarium. But it was eventually in Naples, not in the doomed city of Messina, that he decided to found his laboratory. He came to an agreement with the Municipality whereby they provided a fine site on the sea front in the Villa Nazionale while he was to find the money and build the marine station. This was to remain the private property of the founder and his heirs for ninety years and then to revert to the city but to function as before.

THE BUILDING COMPLETED

Owing to the outbreak of the Franco-Prussian war, building did not start until 1872, and it was completed, after many frustrating delays, two years later. The greater part of the cost was met out of Dohrn's private fortune, the balance being raised internationally and including a gift of £1000 from this country. This was collected largely through the efforts of Thomas Henry Huxley and of Francis Balfour, younger brother of the future Earl Balfour and a brilliant zoologist who met death tragically early in an alpine accident.

In February, 1874, the Stazione Zoologica was formally opened. From the beginning Dohrn was determined that what he had created should be international. Although the German government gave an annual

Laboratory for cell respiration studies.

subsidy—later increased but consequently reduced at Dohrn's suggestion—funds came largely from two sources. One was from the receipts of the aquarium. This soon became famous, it was a much-starred feature in Baedeker, and no visit to Naples was complete without a view of it. The other way was by the brilliant idea of instituting "tables".

INTERNATIONAL CO-OPERATION

By this scheme different countries and different institutions rented working space and facilities and could then nominate scientific workers to occupy these tables. The brilliance of the idea resided in the certainty of income, rent being paid whether the table was occupied or not, and in the connexion established with so many countries. From this country, tables were then or later supported by the Royal Society, the British Association, and the Universities of Oxford, Cambridge and London.

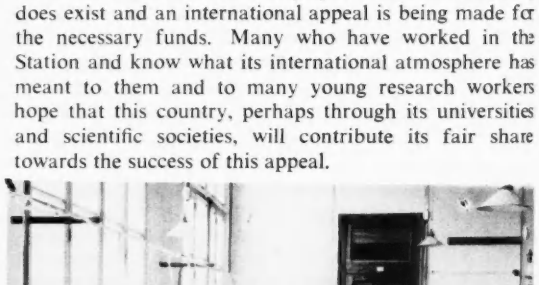
Certainly until 1914 the Stazione Zoologica was the greatest international centre of biological research, large extensions to the buildings being made in 1886. It was the ambition of every young biologist to work there, and the hope of the more senior that they would soon revisit this laboratory where friendships had been made with colleagues from many countries.

Meanwhile visitors flocked into the aquarium. Like their successors today, they viewed the many-coloured fishes and invertebrates, the handsome Roman eels gliding through mouths of antique jars, sinister octopuses and swiftly darting squids, tall anemones with drooping tentacles like miniature and gaily coloured palm trees and—supreme exhibit—transparent, almost unbelievably delicate surface-dwelling siphonophores and ctenophores, the latter outlined with iridescent rows of swimming plates.

Anton Dohrn died in 1909. His son, Reinhard Dohrn, retired last year at the age of seventy-five, and now his son, Peter Dohrn, directs the Station. It is a tribute to them that it has survived two world wars. When Italy declared war against Germany in 1915, the Station was taken over as enemy property. It was not restored until 1924 and then on a new understanding; it was to become the property of the Italian State with an appointed board of management, Reinhard Dohrn returning as director only. Assisted materially by the Rockefeller Foundation, it regained much of its former standing. Although surpassed in size and facilities by certain United States laboratories and by that of the Marine Biological Association of the United Kingdom at Plymouth, it retained a unique international standing.

The Second World War proved a more exacting experience than the First. The Station was fortunate to survive the allied bombing which reduced the harbour of Naples to ruins. Yet even in this period of greatest adversity it remained international. It was the German army which evacuated its magnificent library, which in due course was restored by the British army! After the Allied occupation of Naples in 1943, the Station was saved by a more than timely gift of £1000 from the Royal Society.

Today, as all who visit Naples may see for themselves, the white buildings of the Stazione Zoologica, which gleam brightly among the dark trees of the Villa Nazionale, show evidence of restored activity. The darkened aquarium with its views of the submarine life of the Mediterranean attracts tourists as it always did. Upstairs the research laboratories are again occupied by holders of tables. There workers from many countries (over a tenth of them are from Great Britain) study biological problems of all kinds. There are still many needs, however, notably the provision of new accommodation for the great library which covers every aspect of marine studies. Fortunately space for a new building does exist and an international appeal is being made for the necessary funds. Many who have worked in the Station and know what its international atmosphere has meant to them and to many young research workers hope that this country, perhaps through its universities and scientific societies, will contribute its fair share towards the success of this appeal.



Laboratory for investigation of animal behaviour.

A HUNDRED YEARS OF SYNTHETIC DYESTUFFS

E. R. WARD, B.Sc., Ph.D., A.R.I.C.

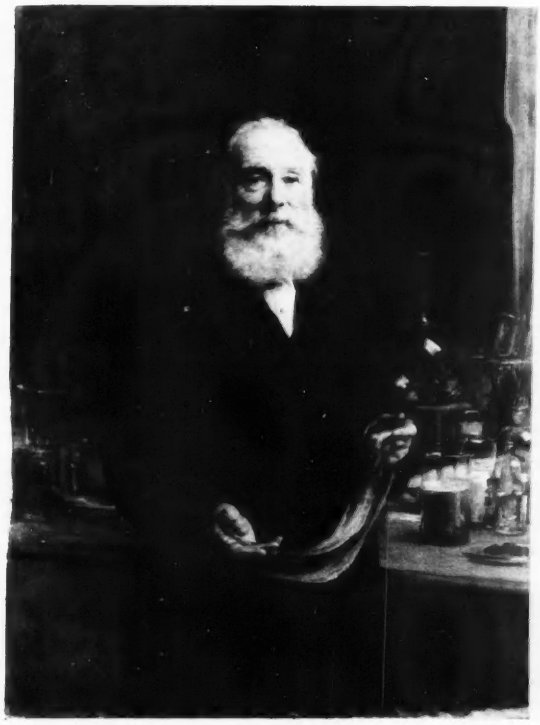
In 1856 Great Britain was still in the midst of the Industrial Revolution. Power was passing from the great landowners to the new industrialists, and an expanding middle class had wealth to indulge in many of the luxuries of life. Empire-building continued, but with the extension of the franchise democracy was advancing. It was singularly appropriate that at this time a precocious young man of eighteen who was making a speculative attempt to synthesise quinine from a coal-tar product, should obtain a beautiful mauve dye instead. This unexpected result led directly to the manufacture of synthetic dyestuffs, a completely new industry which could meet the needs of the times by combining elegance with cheapness. The fact that the new colour (mauveine, Tyrian purple, or Perkin's purple, as the new colour obtained by William Henry Perkin was variously called) could replace the natural Tyrian purple which the ancients obtained from shell-fish, had a special significance. The natural dye had been known for thousands of years and in ancient times had been reserved for the exclusive use of emperors, priests and people of high standing. The new synthetic purple was soon to be available to all, and was thus a precursor of the vast colour industry of today, when even the humblest can indulge in fine and gaudy apparel.

The growth of the synthetic colour industry, and indeed that of the organic chemical industries as a whole, dates from Perkin's discovery of 1856. This year the centenary of the discovery will be celebrated throughout the world. In its public announcements the Perkin Centenary Committee states: "This historic event marked the birth of the dyestuffs industry and the greater part of the organic chemical industry. From these small beginnings have sprung dyes and pharmaceuticals, textile and rubber chemicals, plastics and synthetic fibres, for Perkin's discovery turned organic chemistry from an academic study into a matter of world-wide industrial importance."

PERKIN'S DISCOVERY

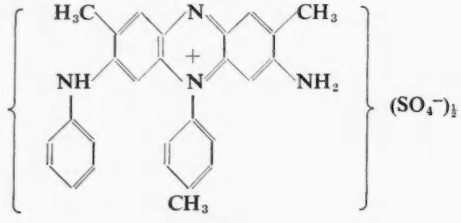
The story of Perkin's work is one of the most fascinating in the whole of science. It depended on a number of fortuitous circumstances, and it reveals his special genius in turning an unsuccessful experiment into an event of major significance. In order to appreciate Perkin's discovery one must first examine the developments in organic chemistry of the twenty years that preceded it. Liebig's work on agricultural chemistry had aroused the interest of the great landowners. They were anxious to arrest the decline in their own fortunes, to satisfy the demands of the industrialists for cheap food for the working classes, and to put up a strong resistance to the competition from imported food. They decided that the application of chemistry to agriculture might be the answer to their problems. This stimulus and their patronage founded the Royal College of Chemistry in 1846. Under the energetic direction of the German professor, A. W. Hofmann, it failed to make much significant contribution to the agricultural problem; however, it provided a means of training chemists, and in particular it concentrated on investigating coal-tar products. At this time coal-tar was largely a waste by-product of the gas industry, and difficulty was found in disposing of it. One of Hofmann's pupils, C. B. Mansfield, had discovered in 1847 how to extract benzene and other useful hydrocarbons from it, and had campaigned strenuously for the industrial development of coal-tar. The dyeing industry was still based on materials of vegetable origin like indigo and madder. Some synthetic colours had been discovered (Runge made rosolic acid from crude carbolic acid as early as 1834), but none of these were much used commercially. This was the position when Perkin made his discovery.

Perkin's interest in chemistry had begun at the age of



Portrait of Sir William Henry Perkin, F.R.S., painted by Sir Arthur Cope in 1906, and now in the National Portrait Gallery, to whom thanks are due for permission to publish.

thirteen and had been further stimulated at the City of London School, where the young boy gave up his lunch hours to attend special lectures by Mr. Thomas Hall, an ex-pupil of Hofmann. His father (a building contractor) wished him to become an architect but eventually allowed him to enter the Royal College of Chemistry in October 1853. Perkin was then only fifteen, but in his second year Hofmann put him to work to investigate the chemistry of anthracene and later promoted him to be a research assistant. Perkin was not content merely to work at the College, but in 1854 fitted up a laboratory at home. Working with Mr. (later Professor) A. H. Church, he prepared a material from naphthalene which was in fact an azo-dye but was not recognised by them as such. It was during the Easter vacation of 1856 that Perkin made his great discovery. Theoretical ideas in organic chemistry were vague at this time, and in 1849 Hofmann had made a speculative suggestion as to how quinine might be obtained from naphthalene. Following this up, Perkin first tried oxidising allyl-toluidine with potassium dichromate, but he only obtained a dirty red material. Repeating this with aniline, he got a very dark-coloured amorphous product, and from this he extracted his mauve, which he found to have dyeing properties. At this time chemists aimed at getting colourless products of uniform composition, every effort being made to get rid of coloured contaminants. Perkin's proper action, therefore, would have been to cast his product down the sink and get on with the next experiment. Instead he now applied his full energy, skill and resourcefulness to turning his product from a laboratory curiosity into a commercial dyestuff. Undoubtedly one of the motivating forces behind this was Perkin's aesthetic tastes, both he and Church being amateur painters. Church even had a picture hung in the Academy in 1854. There was another fortuitous aspect of Perkin's experiment and that was that the aniline used was impure, the toluidine contaminants being necessary for the synthesis of mauve. The dye was only obtained in about 5% yield, and along with the principal component, mauve, there were two other allied dyes, pseudomauvein and saffranine.



Mauveine

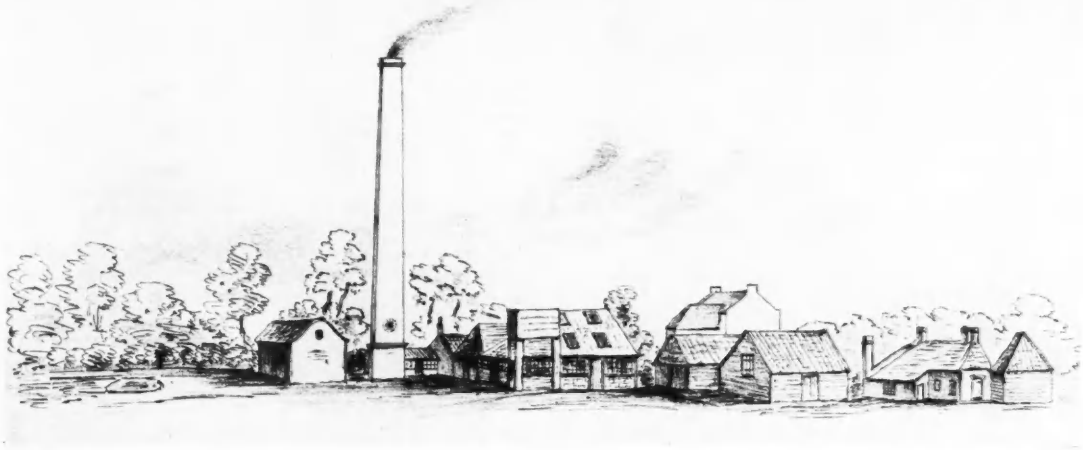
Perkin had no experience of chemical works or of large-scale chemical manufacture. He knew nothing about the dyeing industry, and by nature he was a retiring person with not much instinct for business. Despite all these handicaps and the technical difficulties of applying the dye commercially, he succeeded in his project. Fairly soon (June 1856) he was encouraged by a report from Pullars of Perth on the dyeing properties of his mauveine, and a patent on its manufacture was taken out on August 26, 1856. His father threw most of his life savings into the venture, his brother joined him as close collaborator, and a factory was begun at Greenford Green in June 1857. Perkin himself left the Royal College in October 1856, against the desire of Hofmann, who did not approve of academic scientists associating themselves with industry. Six months after constructing the factory, enough dye was available to supply a silk dyer, Mr. Keith of Bethnal Green. The difficulties of manufacture were enormous, because raw materials like benzene and strong nitric acid were not readily available and apparatus had to be devised for the manufacturing processes.

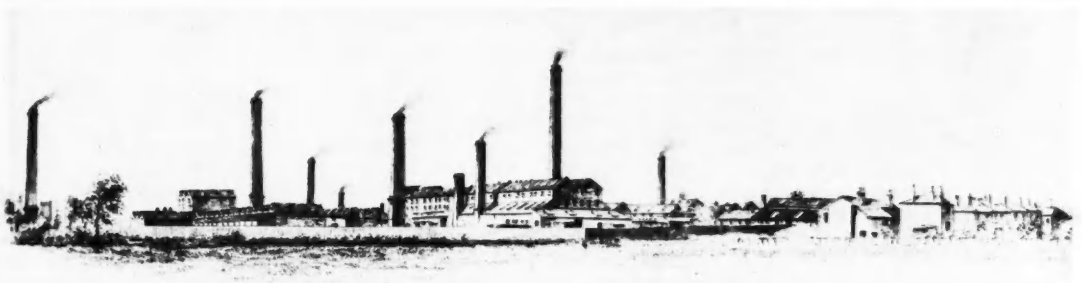
Perkin, however, did owe much of his rapid success to the earlier work of men like Hofmann, Mansfield and Béchamp, who had all made their essential contributions to the development of the coal-tar industry. Perkin was not content just to make mauveine, he spent long periods in dye factories working out novel methods to apply mauveine to textiles. His methods of dyeing were also to prove invaluable in developing the rival coal-tar dyes that were now beginning to appear, for example, magenta in 1859. He also had the novel idea that a chemical manufacturer might provide "technical service" to the consumer of his products.

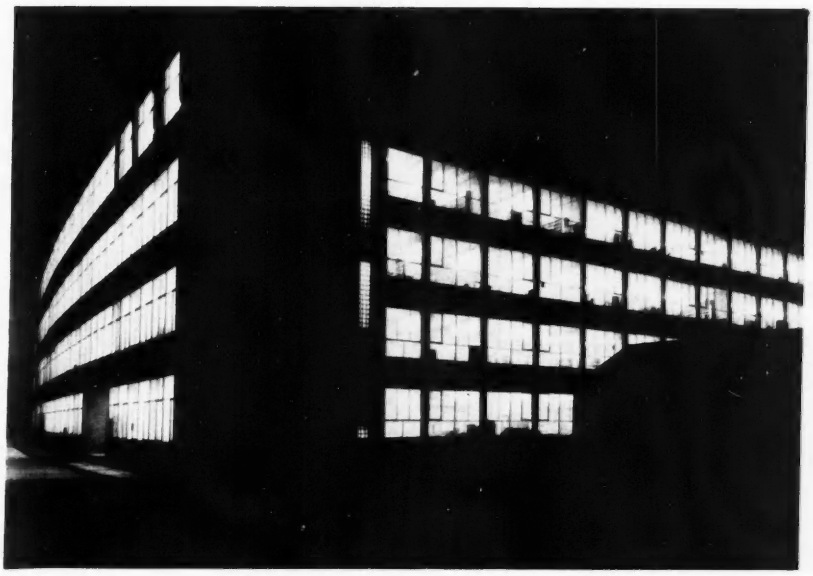
Surprisingly enough the British dyers did not take kindly to the new mauve. It was only after their French rivals, who took advantage of the fact that Perkin's patent was invalid in France, had secured excellent results, that real demand was aroused in the United Kingdom. Great public interest followed. Robert Hunt F.R.S., writing in a popular monthly (*Cambridge Magazine*, 1861) said, "When a lady arrays herself in a fine example of our silk manufacture in these colours (the new coal-tar dyes) she cannot but feel indebted to the science that has produced it . . . we never possessed any tint in which there was so much depth or intensity." The new dyes began to create special problems. Mrs. Merrifield, writing in the same volume on "the use and abuse of colours in dress", declared, "of all colours the most trying to the complexion are the difficult shades of blue and purple . . . the fashionable and really beautiful mauve and its varieties are of course included in this category". Nowadays, of course, complexions can be adapted and modified to the colour, and it is interesting that *Vogue* is featuring an attractive shade of mauve as the fashionable colour for this spring. So ladies, whether they know it or not, are having the shadow of Perkin cast upon them, to commemorate his discovery.

COMMERCIAL ALIZARIN

Mauveine did not last long as a commercial success. Within a few years of its creation many superior coal-tar dyes were put on the market. Both in this country and abroad there were intensive developments in research and manufacture. Perkin continued making new discoveries and doing academic research. In 1868 came his second major contribution. A process had been worked out in Germany for making alizarin, the colour principle of







FIGS. 1, 2, and 3. (*Top*) Sketch by Perkin himself of his first artificial dye factory, 1858. (*Centre*) A contemporary drawing of Perkin's dyeworks, 1873. (*Right*) A modern contrast: exterior view by night of the research block, I.C.I. Dyestuffs Division, Blackley, Manchester.

FIG. 4. View of part of the modern Grangemouth Works, I.C.I. Dyestuffs Division, where the famous light-fast anthraquinone vat dyestuffs are made.

madder, but it was too expensive to compete with the natural article. Perkin now resumed his work on anthracene, his first task at the Royal College, and quickly developed a cheap commercial process for alizarin. The Germans actually slightly anticipated Perkin in this, but amicable arrangements were made and Perkin went on to devise an even better method. By 1878 some 9500 tons of artificial alizarin (equal to more than the whole original output of natural madder) were sold, and the natural madder industry rapidly became extinct.

PERKIN'S LAST YEARS

In 1874 Perkin retired from the colour industry, the Greenford factory was sold, and Perkin built himself a laboratory at his house. For the rest of his life he led the life of a cultured country gentleman, occupying himself with useful academic research in organic chemistry, with his garden, and with music. He had a large family and, guided by their father, his three sons all became chemists of renown. It was not unusual in those days for colour magnates to retire in comparative youth with substantial fortunes, but there were special reasons why Perkin did so. He was sensitive, deeply religious, and stern of habit, being a teetotaller, a non-smoker and a strict vegetarian. He was worried by the fires and explosions that occurred in his works, irritated by litigation over works effluents and the weakness of English patents. His great desire seemed to be to live up to Hofmann's ideal, the academic man of science untainted by manufacturers. In his later life he achieved the social success that was applauded in those times.

The suggestion has been made that the appalling decline in the British colour industry towards the end of the 19th century was due to Perkin's withdrawal from the industry. A provocative and stimulating discussion of the problem is given by J. G. Crowther in his article on Perkin (*British Scientists of the 19th Century*, vol. 2, Penguin Edition). The facts are these: at the turn of the century Britain was content to export vast amounts of raw coal-tar to Germany, where it was processed by the German colour industry which had secured an almost complete world monopoly. British industry apparently had not been prepared to carry out the detailed technical research and development that the organic chemical industry required. British capital went into other ventures, where profits were more easily earned. Technical education was sadly neglected in the great public schools and only half-heartedly attempted in the universities; for instance, Hofmann himself had returned to Germany in 1865, frustrated by British apathy.

When World War I began (Perkin had died in 1907, his unique genius rewarded by a knighthood, election to the Royal Society and innumerable honorary degrees) Britain immediately suffered from this neglect, not so much through the absence of a large colour industry, but also because of the immaturity of the chemical industry as a whole. Even such elementary materials as oleum to make TNT were not available. Only by great resourcefulness in the hour of need did the chemical industry develop sufficiently for the war to be won. There was a short lapse afterwards, but with the formation of Imperial Chemical Industries in 1926 the battle was won. Outstanding discoveries were made by British chemists, both in organic chemistry and biochemistry as well as on colour. Sir William Perkin and his eminent sons, who did so much in their own quiet way to foster research work, would have been well content with the results of his "fortuitous" discovery. Just now there is so much interest in atomic energy that the organic chemical industries are less in the news, but they are an essential component of the economy of any modern State. Their "father figure" is Perkin, and around him has been cast an almost magical aura of devotion.

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AUTOMATION: NEW TOOL OF MANAGERS

SIR WALTER PUCKEY

Automation Consultants and Associated Ltd.

Sir Walter Puckey was trained as an engineer and has worked as designer, departmental, works and general manager in a variety of companies. In 1951 he resigned his directorship of Hoover Ltd., following his appointment as Deputy Controller of Supplies (Aircraft Production). He retired from this temporary appointment in 1953 and resumed his industrial activities. Currently, he is on the Boards of a number of companies including the British Tabulating Machine Co. Ltd., Hollerith, English Numbering Machines Ltd., and Everett Edgcumbe & Co. Ltd. Among many other activities, Sir Walter is a member of Council of The Institution of Production Engineers, The British Institute of Management, and the British Productivity Council. Last year he founded a group of Automation Consultants, this being the first of its kind in Britain to provide a comprehensive service on Automation.

What does "automation" mean? Is it something new, or merely an existing technique with a new name? The answer is that it embodies the existing in the form of mechanisation, but to it is applied a new form of control over machines which makes mechanisation more effective. It can not only do this in those industries or factories where machine power has become an accepted aid to output, but, through its greater ability to "control", it will increasingly be used to facilitate the use of machines in other sections of our working community.

Let us examine the national scene. Out of about 24 million people "gainfully employed" probably only about 8 million, or one-third, work on the factory floor or its equivalent. They may usually be recognised as people who are "paid by the hour". The second important group contains roughly another 8 million people, who will be found in offices of all types—factory, commercial, sales, etc. The remaining 8 million people are employed in what we might loosely call "service" occupations, such as transport, wholesale, retail, financial and H.M. Forces. Unfortunately national statistics do not give us precise figures, but the above grouping is probably accurate enough for present purposes.

AUTOMATION IN FACTORIES

How has mechanisation affected these three groups? Obviously, the first Industrial Revolution made its greatest impact on factory workers, who were the first people to feel the impact of the great achievements and, in some ways, the great difficulties brought about by the machine. Today most believers in automation as an advanced form of mechanisation would like to introduce it first on the factory floor. But factory workers must occasionally feel like microbes under the microscope, and wonder whether greater attention to other sectors of human activity would not also repay intensive study; whether, in fact some observers would not be wise to look first at their own efficiencies.

AUTOMATION IN OFFICES

What about the second group, the office workers? There are millions of clerks and billions of pieces of paper in this group, and yet, despite the obvious possibilities of mechanising much of this work, little has been done until recently. In 1935 the total output of Britain's office machinery producers was about £1½ million. Today it is running at about £55 million, a very rapid growth indeed, and in total as much as the British machine tool output of only a few years ago. The electronic computer, described by some as "the heart of automation" is making a great impact upon office managers and accountants. It is increasing the number of firms interested in the provision of modern office equipment and, equally important, it is causing a greater demand for existing mechanical and electrical office machines. An even more important trend is the stimulation given to the use of the computer as a tool of scientific investigation, management and production control.

Great changes are about to take place in the organisation, techniques and staffing of offices; and, as an instrument in these changes, automation will play an even greater part than it does on the factory floor.

AUTOMATION IN PUBLIC SERVICES

The third group of workers is rather amorphous. It includes the road and rail transport hourly paid worker, the person who sells you a ticket in the travel agency, the bank clerk and the soldier. Together these many

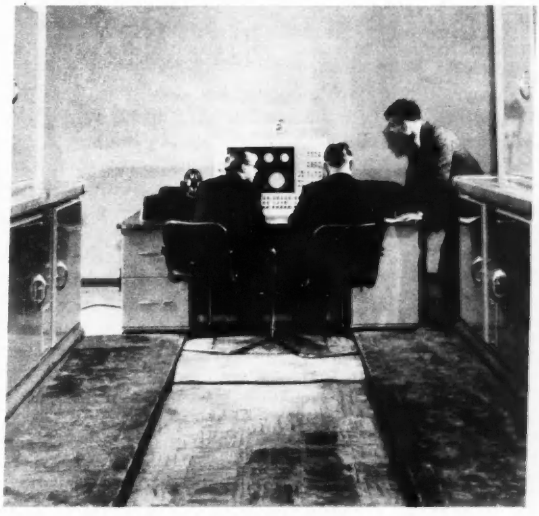

FIG. 1. The Ferranti Digital Computer Mark I, installed at the University, Manchester. Standing on the right is Dr. A. M. Turing, F.R.S., of Manchester University.

FIG. 2. This electro-mechanical analogue computer simulates the flights of guided missiles without their having been fired. It can give answers to problems with as many as twenty variables.

people total about 8 million, and their efficiency plays a very important part in Britain's efficiency. Their cost to companies and country is growing, and according to many observers, their standards of "customer satisfaction" are unfortunately diminishing. One thing seems certain, any increase in our standard of living must require higher standards of service with, if possible, lower costs. Much greater attention should be paid to the efficiencies of the 8 million people in this section, and more machine power will be one of the important factors.

How will this machine power be applied? A few days ago a member of a busy office staff spent over thirty minutes in a well-known travel agency waiting for a sleeper and railway ticket that had been ordered several days earlier. Such a waste of time is inexcusable when new booking machine aids such as those now being applied in U.S.A. to aircraft and rail booking are available. Millions of cheques take much too long to sort and clear because the banks have not yet standardised, simplified and fully mechanised the paper and procedures. Rail travel will probably become smoother and faster when the new diesel-powered trains arrive, but we know from recent experience that control power in the form of better signalling and handling must also be installed to complete the investment.

Rapid changes are taking place in methods of self-service for wholesale-retail distribution. This trend may considerably alter the preparation and packing of goods, their transport arrangements and the control of stocks.

In all these operations, and many more, the tools of automation will be helpful. The computer will provide more significant control statistics which can be rapidly communicated between machines, departments, shops and factories, covering if required a wide geographical area. Already such an installation as LEO (Lyons Electronic Office) is stretching its communicating links, and the improved methods of stock control in remote tea-shops and internal departments illustrate how much the computer can assist other people as well as the accountant.

ORGANIZATION PROBLEMS OF AUTOMATION

Any tool which can be used in many departments must be of great interest to senior managers, because their task is essentially one of co-ordination and control over the many. Automation can break down departmental barriers and the machine can often help to provide co-operation which men sometimes find it difficult to attain. Let me illustrate this by an example. A certain Company installed an electronic computer and then circulated a note to all senior managers of its various divisions saying that "the machine was now available to give service". The managers wondered just what the word "service" meant, and naturally no response came. It was then decided to send round a senior computer engineer to explain what sort of problems the machine could help managers to solve. The result was that problems flooded in. As these were largely inter-departmental, the subsequent discussions considerably increased co-operation between managers.

New methods for precise weighing and batching, such as those described by Bourgois,* make it possible to control many operations from a central source. Let us

* Bourgeois, P. J., "Automatic Selection, Weighing and Conveying—Quality and Quantity by Remote Control" in *The Automatic Factory, What Does it Mean?* Published on behalf of the Institution of Production Engineers by E. & F. Spon, 1955, p. 154.

FIG. 3. A general view of J. Lyons and Company's "LEO" operating floor. The operator on the left is standing by a bank of machines which feed basic information into the calculator by means of punch cards. Behind him is the second channel of information to the calculator, this time by means of perforated telegraph tape. The operator on the right is standing at one of the two printing units, which record in normal type on continuous rolled stationery the results produced by the calculating units in the cabinets on the right, behind the pillar.

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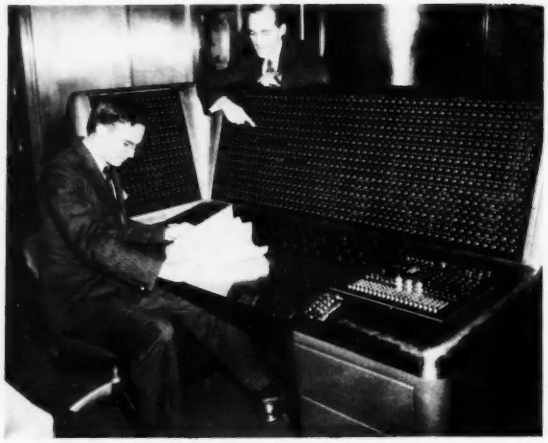


FIG. 4. The calculator used by Prof. John A. Wheeler of Princeton, and Mr. David L. Hill, now of Vanderbilt University, to produce the equivalent of a slow-motion picture of the splitting of the atom. This research was a development of ideas advanced by Niels Bohr. Mr. Hill is seated at the left of the calculator, while R. R. Seeber, co-inventor of the calculator, points to the keyboard.

suppose a variety of materials (powder or liquid) are required to make up a certain "mix". Instructions are fed into a computing machine in the controller's office, and these are transmitted automatically to the bulk containers. Precise amounts of the various materials are fed to common points for mixing, weighing and, if required, packing. Every packed unit (drum, case, etc.) is notified automatically to stores and despatch departments, so that loads can be made up, transport planned and stocks adjusted. Automatically at the same time the accounting information is tabulated and the sales department instructed so that customers may be told.

All of these things can happen in parallel rather than in series, and they can be done without human agencies. They link departmental activities closely, and they raise new organisational problems and possibilities. Where, for instance, should the control point be, and who should be the controller? Is the accountant suitably trained to control the computer, which may increasingly become the nerve centre of the whole organisation. Many people would say that the accountant is not yet qualified by experience or temperament to take this responsibility.

AUTOMATION AT HOME AND ABROAD

Everyone interested in automation applied to the factory floor must have found much of interest in Dr. Lilley's article in DISCOVERY last year,* and in his latest description† of Soviet progress. He has rightly been cautious in assessing their achievement although, like other recent observers, he has not failed to notice the rapid advances in technology made by the Russians, whether in the provision of technological educational facilities and numbers of people trained (as mentioned recently by Sir Winston Churchill), or in the number of first-class projects on the ground.

Although Russian progress in technology has been rapid, there is comparatively little information about her progress and practices in personnel management. This is in contrast to Britain and the U.S.A., where there has been even more discussion about the effects of automation on men than on machines. In Britain the Trade Unions have given a lead by stating that automation should not be resisted, and that in fact if it is applied in a reasonable manner it is beneficial to all. Nevertheless certain politicians are attempting to prove that its impact will be so profound as to require a greater degree of government control over certain industries and investments.

In the programmes of the many conferences and lecturer series on automation, many papers deal with the human problems, and in Britain the whole subject is being discussed in a balanced way which is very encouraging.

Much the same situation prevails in the U.S.A. Before the war American managers paid little attention to personnel problems; technological requirements came first. Today we can learn much from the United States about personnel management, especially as it concerns automation.

Other countries, too, are giving as much attention to human as to technical problems, and one would like to know whether Russia is doing the same, or whether, as one suspects, she does not find the same necessity. One is reminded of the commissar who was sent from Moscow to inject a greater enthusiasm for mechanisation into the rather reluctant workers on the collective farms of the Ukraine. After a few weeks' silence a progress report was demanded. It came in the form of a telegram: "Taken first step towards mechanisation, shot all horses."

CONCLUSIONS

One thing seems clearly to emerge. Machine power in the form of automation will increasingly invade territories where formerly machines existed only in simple form and where communication was mostly between men and men. This wider application will raise many problems which will concern many people. Scientific and technical progress on various specialised projects is very rapid today, but less attention has so far been given to the co-ordinating tasks which will concern technologists and managers alike. The first group will find themselves more concerned with the effects of their work on the men and women required (or possibly not required), and managers will need to give much more attention to human problems and to the organisational problems involved in using machines more intensively in control activities.

Given a full appreciation of these wider applications of machines, and an anticipation of the technical and human problems, I believe that automation will bring new opportunities and many benefits to all.

The illustrations to this article show modern computing machines in Great Britain and the U.S.A. Computers like these, or smaller similar models, are the essential instruments for all automation.

* DISCOVERY, April 1955, p. 147.
† DISCOVERY, March 1956, p. 109.

ASPECTS OF INDUSTRIAL GAS TURBINES

LEO WALTER

During the last decade the gas turbine as a prime driver of alternators, compressors and pumps, and for other industrial purposes, has been developed from an aeroplane engine. At first it was hailed as a discovery which might well oust other conventional machines such as steam turbines or oil engines. People visualised a rotating power machine burning any type of fuel efficiently and economically. It was realised, of course, that the thermal efficiency of the early designs was not what it should be, but the designers and makers of stationary gas turbines hoped that advances in metallurgy would provide new materials able to stand up to higher temperatures in the combustion chamber and turbine rotor. Most makers of the new gas turbines had manufactured steam turbines for many years. Designers of the new prime movers thought they had only to base their designs on old steam turbines in order to obtain a machine which would be just as reliable and easy to operate. As with many other discoveries, the difficulties were overrated at first but underrated later. In spite of the two gas turbines in operation in power stations in this country, the twenty or more American gas turbines in use for power generation, and the Swiss machines in operation in various parts of the world, the design of combustion chambers, rotor blades and other elements has still to be improved.

It is dangerous to be too optimistic about a new discovery during the early stages of development. The new industrial gas turbine is not a failure, though developments in this country are much too slow. From the first drawing-board stage to test runs, a machine may take three or four years or more to develop, which is much too long in practice. A certain secrecy on the part of designers and makers of gas turbines on one side, and of users on the other, also retards progress. It is understandable that makers do not wish to disclose failures during factory tests or to reveal too many of the "teething" troubles of new plants in operation. What is less understandable is that users in this country are unwilling to make their experiences known. For example, one gas turbine is now intermittently operating as a stand-by set for peak loads in one of the biggest power stations in the north, but not a single operational figure has been published for about two years. It is merely rumoured that there are still "teething troubles". A leading Swiss manufacturing firm, on the other hand, frankly admits that in one of its early plants a heat exchanger caught fire due to inflammable deposits on the tubes and was destroyed. Hush-hush methods will avail nobody and will probably cause unfounded rumours about inefficiency.

ADVANTAGES OF THE GAS TURBINE

Since the early days of Swiss-built gas turbines the type of engine shown in Fig. 1 has been greatly improved. Questions about the capabilities of the gas turbine as compared with contemporary oil-and-gas reciprocating engines have been answered by trial test installations. These tests have revealed greater smoothness both in torque applied to the driving shaft and in the reactions at the machine supports, which allow very light fundaments. Good torque characteristics, with ability to start quickly and to accelerate heavy loads smoothly have also been developed, especially in two-shaft engines. The flexibility of control is superior to that of any piston engine, because a gas turbine can accelerate and decelerate faster, and before the machine has been warmed up. It is claimed that this speed of change from idle to full power is as rapid and smooth at zero runs per minute of the main turbine shaft as at full speed (Fig. 1).

There are other advantages, such as almost complete elimination of the need for cooling water, and ability to generate on much lower fuel specifications. One of the best-known and most favourable features of the modern stationary gas turbine are the small size and light weight, so that it can be easily transported and quickly installed. The gas turbine can be made more efficient than steam engines. By using waste-heat boilers it can be used for combined power and heat (Fig. 2).

For base-load power-station use the gas turbine has great attraction wherever there is natural fuel such as mineral oil, natural gas or waste gases from industrial processes, and where solid fuels have either to be imported and are expensive, or are scarce. If we look at a list of gas turbines in operation we see that they have been located where fuel can be thus saved.

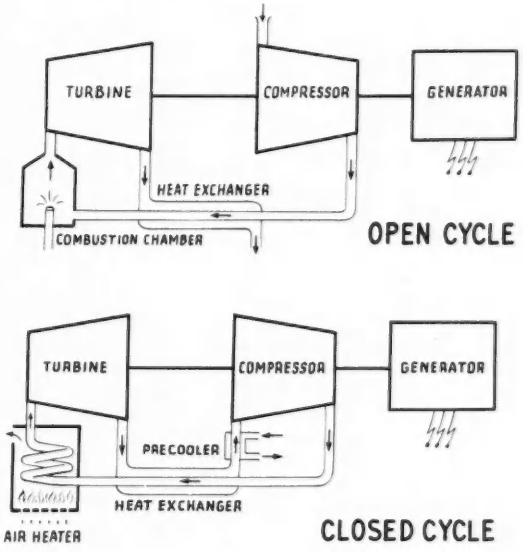


FIG. 1. Diagram of gas-turbine cycles.

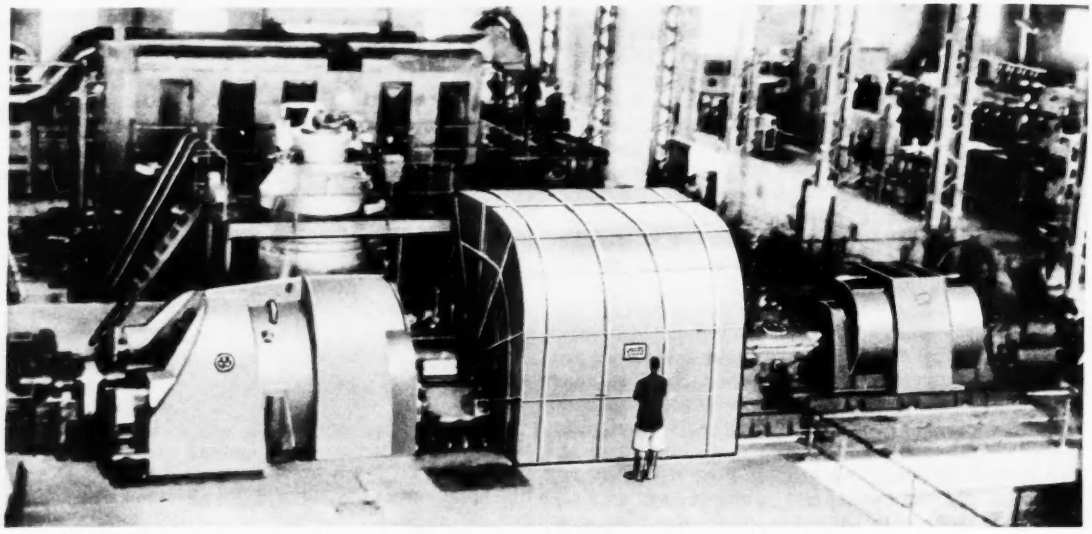
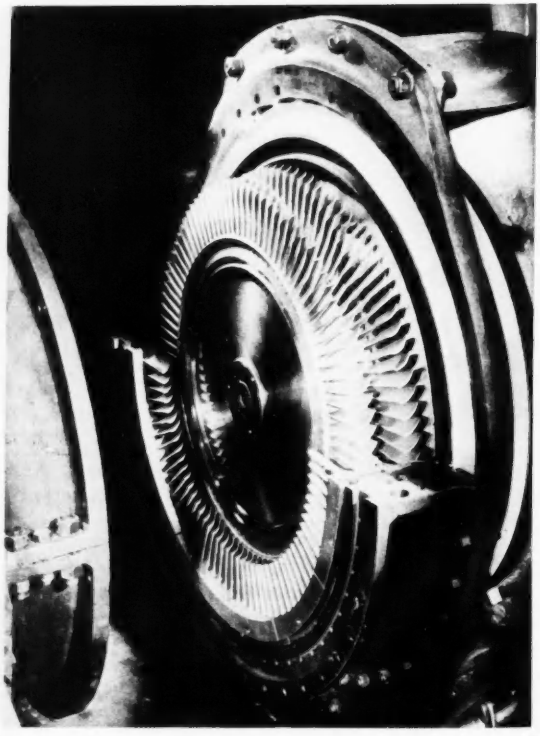


FIG. 2 (*above*). The first of two BTH 2500-kW gas turbo-alternators installed in Nairobi South Power Station, East Africa. (*Courtesy of British Thomson-Houston Co. Ltd.*)

FIG. 3 (*below*). Power turbine of TA engine, with top half stator casing removed.
(*Courtesy of Ruston and Hornsby Ltd., Lincoln.*)



SOME DISADVANTAGES

In an excellent book on industrial gas turbines a leading expert says:

> "The next few years are likely to be full of disappointments for those who believe in the eventual widespread use of the gas turbine . . . It is to be expected that many of the sets at present under construction or in development will fall so far below their design performance that they will have to be used for experimental purposes only" (Fig. 3).

This to some extent explains why industry in this country has sometimes been slow to place orders for gas turbines. It is to the credit of British government and municipal bodies that they have placed orders on a more or less experimental basis, and that the Ministry of Fuel and Power, the Central Electricity Authority and the Metropolitan Water Board have taken calculated risks which private industry did not seem willing or capable of doing.

The fact that rotor temperatures may be about 675°C, corresponding to red heat, might deter some potential users from installing a gas turbine. The danger of explosion of a combustion chamber is theoretically always present, but in practice, to the writer's knowledge, precautions taken in the various designs have prevented any occurrence of this kind, although in the early days a heat exchanger was destroyed during operation on the Continent.

The industrial gas turbine cannot use any type of fuel. It can, however, use a greater variety of fuels than other engines. Generally speaking the best results are obtained with light fuel oils similar to those used in oil engines, but heavy residual fuel oil, pulverised coal, methane, pulverised peat and other waste products can be burnt. The fuel sprayers for liquid-fuel burning can be similar to those of oil burners. The combustion chamber can have a refractory lining, or can be made entirely of metal. To assist in atomisation of heavy oil.

some makers apply an air injection system. The chief difficulties arise from condensation and solidification of combustion products which make blades foul or cause deposits where they are not wanted. If the fuel has about 3% ash content, over 150 lb. of ash can pass through a gas turbine of 10,000 horse-power using 5000 lb. of fuel per hour. It is hoped, however, that special combustion techniques and the use of additives will in time prevent fouling. If it is to burn fine coal particles (a consideration of special interest in this country), a coal combustion chamber must be as large as that used for experimental purposes at the Fuel Research Station, Greenwich, which is of rather costly design (Fig. 4).

The reliability of these machines in day-to-day operation has sometimes been doubted. The fact that makers advertise them as "long-life" engines does not impress anybody; neither do figures derived from the test bench. Swiss and American manufacturers can place operational results in front of potential users. British manufacturers are not in the same favourable position (see table).

BRITISH INDUSTRIAL GAS TURBINES

Firm	*Rating*	*Remarks*
W. H. Allen & Sons Ltd. Bedford	1000 kW 300 h.p.	Test Unit for Admiralty.
British Thomson-Houston Co. Ltd.	2500 kW	For Nairobi Power.
John Brown & Co. Ltd., Clydebank	500 h.p.	Experimental for Ministry of Fuel—coal burning.
John Brown & Co. Ltd., Clydebank	700 kW	Gasworks, Coventry, Foleshill.
John Brown & Co. Ltd., Clydebank	12,500 kW	Dundee, Scotland.
English Electric Co. Ltd.	2000 kW	1 coal, 1 methane for Ministry of Fuel and Power.
English Electric Co. Ltd.	1875 kW	Stand-by, Ashford.
English Electric Co. Ltd.	20,000 kW	2 on order for Ministry of Supply.
Metropolitan-Vickers Electrical Co. Ltd.	2000 kW	1 for own power, 1 on producer gas.
Metropolitan-Vickers Electrical Co. Ltd.	1750 kW	For Shell Petroleum, Venezuela.
Metropolitan-Vickers Electrical Co. Ltd.	2500 kW	Metropolitan Water Board.
Metropolitan-Vickers Electrical Co. Ltd.	15,000 kW	Trafford Park Power Station, Manchester.
Pametrada	2000 h.p.	For combustion tests.
C. A. Parsons & Co. Ltd.	500 h.p.	Experimental, pulverised coal.
C. A. Parsons & Co. Ltd.	2500 kW 10,000 kW	Shop-test unit for Pyestock N.G.T.E.
C. A. Parsons & Co. Ltd.	15,000 kW	Shop-test unit Dunston.
Ruston & Hornsby Ltd.	750 kW	A number of sets on order for various fuels, including methane.

COSTS

The following remarks on the economic aspect of gas-turbine plants (Fig. 5) are based mainly on data from the U.S.A. and Switzerland, where operational experience is longest. There are over a hundred power plants in U.S.A. and in Europe, and after an average run of five years or so, operation costs have been obtained for some of these. In order of size the uses in

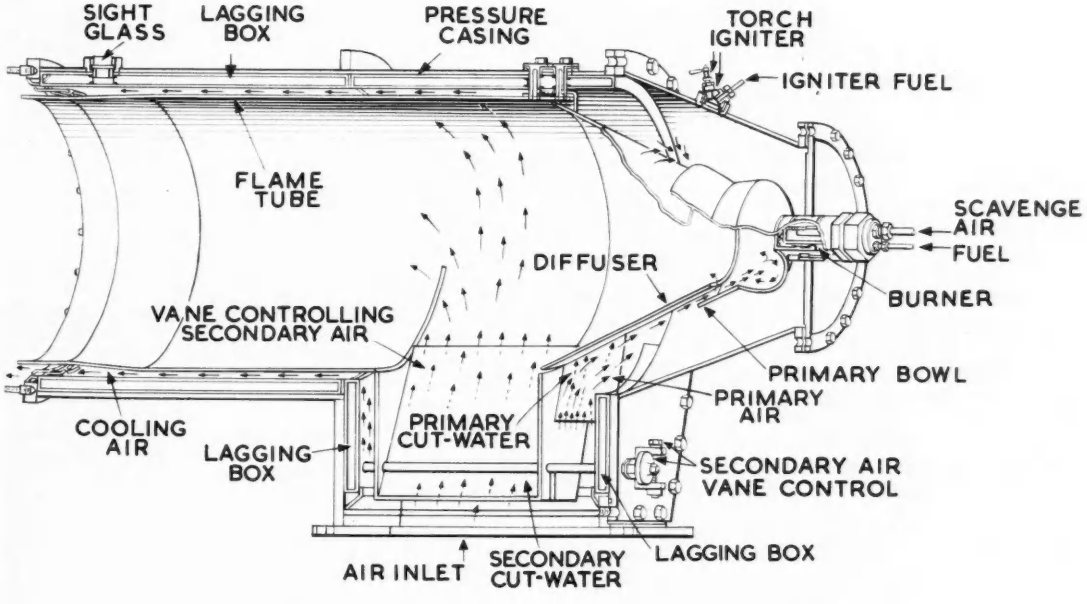


FIG. 4. Diagram of elbow combustion chamber with burner for liquid fuel.
(Courtesy of Ruston and Hornsby Ltd., Lincoln.)

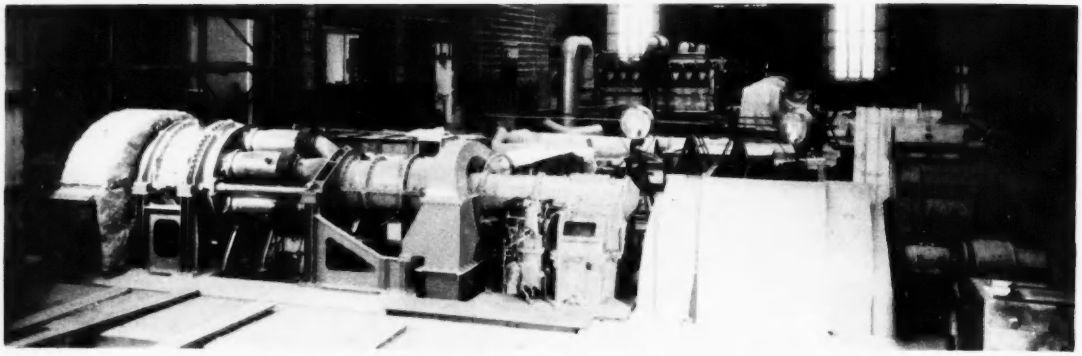


FIG. 5. A gas turbine and turbo-generator (2500 kW) being installed for the Metropolitan Water Board, London. (*Courtesy of Metropolitan-Vickers Electrical Co. Ltd.*)

U.S.A. are: (1) driving of booster compressors for natural gas transmission (an application which does not include Great Britain; (2) driving alternators in electric power stations; (3) process gas turbines using waste-heat gases, etc.

The economics of prime movers are usually based on (*a*) first installation, (*b*) running costs, including supplies and labour, and (*c*) maintenance costs. C. J. Burke of Westinghouse Corporation has published data on the first American gas turbine to be used for natural gas transmission. He gives comparison figures when using the unit rated at 1800 horse-power at 8750 r.p.m. compared with a reciprocating compressor powered line, whereby space is only half for the gas turbine. He also compares transportation costs between the twenty-three gas-turbine stations on a 26-in. pipeline and eleven reciprocating-engine stations on a 30-in. pipeline for natural gas. An estimate also states that about half the number of personnel is required for a gas-turbine power station compared with steam-electric operation, and in general it seems to be established that the gas-turbine booster station is more economical.

The economics of gas-turbine plants are mainly based on what is called flexibility of operation. This term refers here to ability to install additional power to existing plants without increase in boiler plant. As mentioned before, another economical advantage is that it is possible to utilise exhaust gases for generation of steam or hot water in a waste-heat boiler. The easily transportable gas-turbine plant, dependent only on fuel supply and without the need for cooling water and its implications, is the prime mover most suitable for inaccessible locations in oilfield, desert, etc.

W. Van Tassel of the Montana-Dakota Utilities Co. describes the addition of a gas-turbine power unit to an existing steam-electric plant. Oil was discovered near Williston, North Dakota. Two American G.E.C. 4000 kW gas turbines of simple-cycle, dual-fuel type solved the problem of generating sufficient energy. An existing conventional building housing an older 2000 kW steam-turbine plant was converted. Delivery time was only thirteen months; U.S.A. $175.00 per kW capacity is regarded as a very low initial investment which could not have been achieved with any other source of additional power.

The International General Electric Co. of New York claim that American-built G.E.C. gas turbines have set a world operating record. There are 70 G.E.C. gas turbines in operation (about ten times as many as British-built units). It is claimed that G.E.C. gas turbines have delivered more than 350,000 hours of service, equal to forty machine years. The makers say that at one public power station only thirty-four out of 31,000 operational hours were idle. In another plant 9000 running hours elapsed without any unscheduled shut-down.

Messrs. G.E.C. of New York also claim that a combined operation of a simple-cycle gas turbine of their make with a medium-pressure steam turbine can be very economical. A case is the Belle Isle power station of Oklahoma Gas and Electric Co., where a natural gas-burning gas turbine added about 4000 kW of direct generation to 3000 kW from steam turbines. The above combination is said to have resulted in a reduction in the heat rate of the base station in the order of $2\frac{1}{4}\%$, and in an increase of $\frac{1}{2}\%$ of thermal efficiency for the power station as a whole.

Another leading maker of gas-turbine plants is the Westinghouse Electric Co. of Pittsburgh, Pa. They have designed their stationary industrial gas-turbine units on the principle of simplicity combined with reliability. That their designs are sound has been proved by the many operational hours of Westinghouse gas turbines in various branches of the American industry.

Fig. 6 illustrates the instrument panel of a 5000 horse-power Westinghouse plant. It is a compound open-cycle type unit with regenerator, gives excellent flexibility, and possesses good horse-power speed characteristics with fuel rate natural gas/horse-power per hour. It should be noted, however, that the effect of compressor air inlet temperatures and altitude of location is considerable on power output with gas turbines in general.

A 10,000 kW gas-turbine power station at the Ministry

of Supply's National Gas Turbine Establishment, Pyestock, Farnborough, Hants, was successfully synchronised with the National Grid on March 25 of this year. It was constructed by C. A. Parsons & Co. Ltd., and is of the open-cycle, two-line type, with intercoolers, running on liquid fuel. Waste heat from the exhaust gases is made to provide site heating for the Establishment through a district heating system. This is the first time such a system has been used with a gas turbine and enables an overall efficiency of 40% to be obtained. The station has been built mainly for studying problems associated with the industrial application of the gas turbine. The electricity generated will supplement the supply from the grid for the research and development of gas turbines.

SWISS GAS-TURBINE OPERATIONAL DATA

A survey of this kind would be incomplete without reference to operating experience in Swiss power plants. The best-known gas-turbine plant operates at the Beznau power station in Switzerland (Fig. 6). Two Brown-Boveri gas-turbine sets, one of 13,000 kW and the other of 27,000, have operated since 1947 and 1949 respectively. Another gas-turbine power plant in Weinfelden in Switzerland has a capacity of 20,000 kW and a third smaller plant in Neuchatel. The design data for both units at the Beznau station was based for load during 2000 to 3000 operational hours in the winter months. The 13,000 kW set (with gas inlet temperatures increased from originally 600°C to 650°C) has a record of 6000 running hours at 600°C, and of 2100 hours at 650°C up to about the middle of 1953. The 27,000 kW set operated until April 1953, over 5500 hours, and produced a total of 103 million kWh. Table C gives a detailed account of operational times of both gas turbine sets up to April 1953. No financial data are yet available for this plant running on heavy fuel oil, but fuel is exceptionally cheap and abundant in Switzerland, and there is ample water power. In a paper read by Mr. A. E. Kerez (Zürich) the maintenance cost figures were given as 0·02d. per unit generated, as compared with 0·042d. per unit generated as an average for all steam-electric power stations in Great Britain. Tests of the larger set at Beznau revealed 31% efficiency at about 30,000 kW based on 5°C air inlet temperature and 5°C cooling water temperature. Similarly about 28% are claimed for the smaller unit running on Bunker C oil. It is hoped that the owner of the plant, the Eastern Swiss Power Supply Co., will eventually make actual running costs available.

FOR PROCESS—STEAM OR GAS?

An article from W. C. Bloomquist and W. B. Wilson of the Engineering Department of the General Electric Co., Schenectady, New York, discusses whether a conventional steam turbine or a gas-turbine set with waste-heat boiler is the best choice of power energy.

When the gas turbine is credited with the heat in its exhaust gases which can be recovered for various uses in industry, its cycle efficiency can be as high as 70% or more. This is comparable to the cycle efficiency of a good uncondensing steam-turbine plant used to "top" other turbines or to supply steam for process use. Conventional steam turbines should be used when the ratio of electric power to process steam is low—say 2500 to 500 kW per 100,000 lb. per hour steam flow, which is 20 to 40 lb. of process steam per kWh. Gas turbines should be used when the ratio of electric power to process steam is high—say 8000 to 10,000 kW per 100,000 lb. per hour steam flow, which is 10 to 12 lb. process steam per kWh. In the intermediate range of process steam requirements, either the condensing-extraction turbine, the gas turbine using exhaust-heat recovery boilers with supplementary firing, or a combination of the two may be used. In practice, this ratio of process steam per kWh varies widely. The overall average in industrial plants that can use process steam is perhaps no more than 25 lb. per kWh, and with the rapid increase in the use of electric power the ratio is likely to decrease still more. In some new plants and particularly in the expansion of existing plants, the ratio of process steam to electric power requirements may be quite low. The gas turbine is suitable for certain branches of industry using large volumes of steam.

SELECTION OF FUEL

Experiments are being made with a variety of fuels for the combustion gas turbine. Gas or distillate oils are excellent fuels. No doubt satisfactory equipment

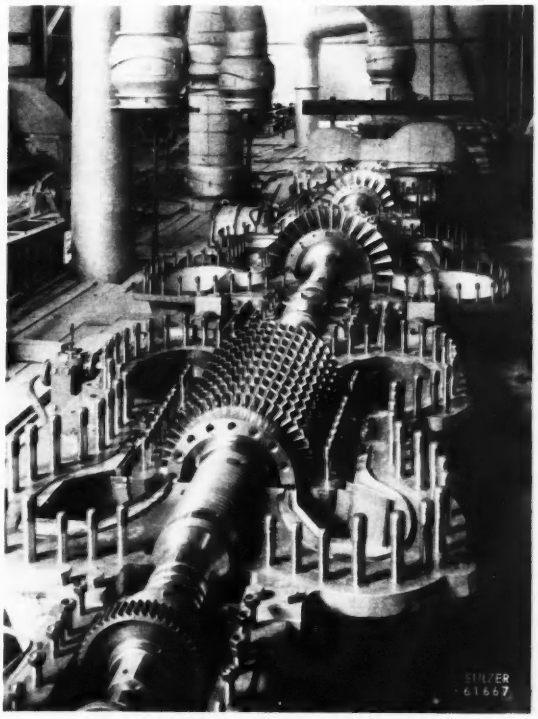
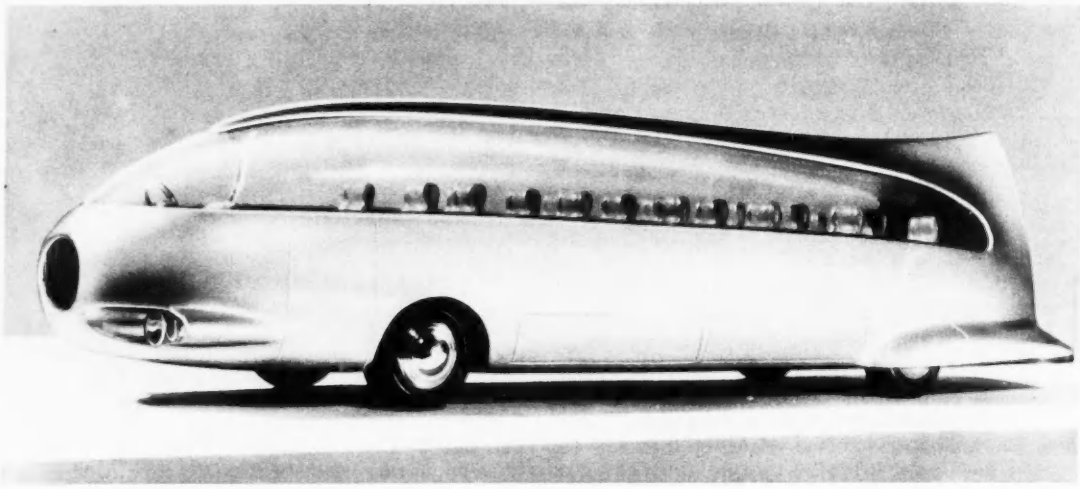
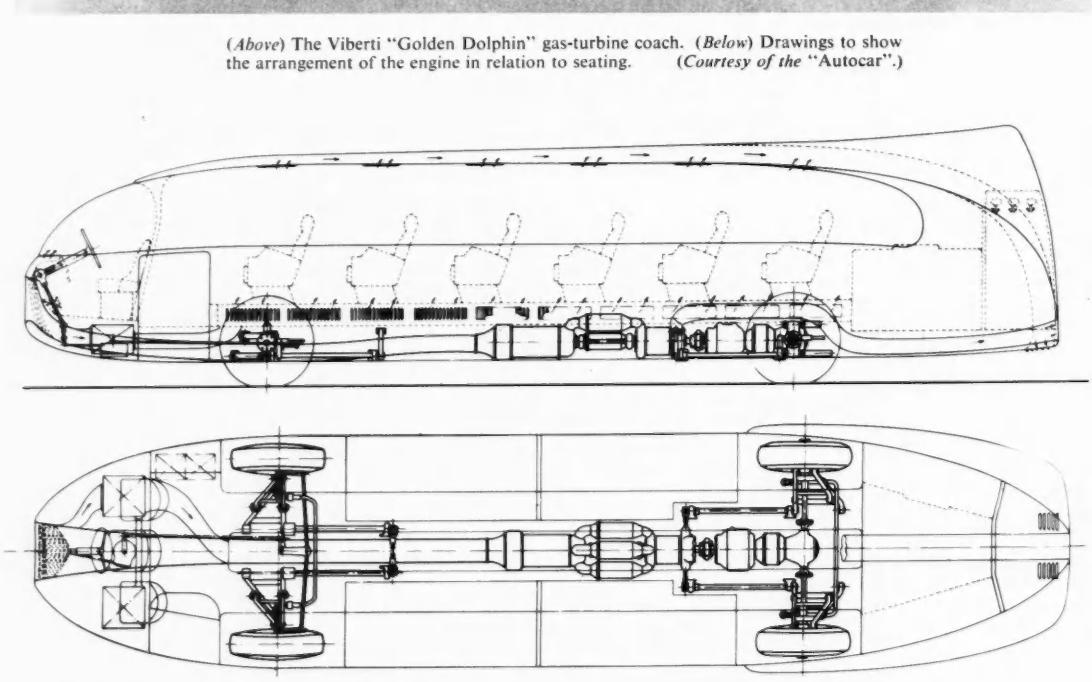


FIG. 6. A Sulzer gas turbine during assembly.
(Courtesy of Sulzer Bros. (London) Ltd., and Zürich.)



(*Above*) The Viberti "Golden Dolphin" gas-turbine coach. (*Below*) Drawings to show the arrangement of the engine in relation to seating. (*Courtesy of the* "Autocar".)



will be developed so that other fuels can be used commercially. At present the steam-turbine plant can use a much wider variety of fuels if these are burnt in boiler furnaces. This is a handicap for the gas turbine in areas where the cost of suitable fuel is higher than that of fuels for other power plants. On the other hand it can be assumed that this handicap is partially offset by the greater simplicity and lower cost for the gas turbine.

CONCLUSIONS

The cost of a new gas-turbine plant is approximately three-fourths that of a comparable steam plant, but much depends on existing conditions. In each plant accurate and complete installation and operating costs should be established. With such information the proper selection of the source of power can be made, whether this be purchased power or local generation, or a combination of both.

ARTIFICIAL INSEMINATION AND DOG BREEDING

A. E. HARROP, M.R.C.V.S.

The author qualified as M.R.C.V.S. in London in 1939, was in general practice until 1946 and then took an appointment as a Government Veterinary Officer with the Government of Southern Rhodesia; he was promoted to the rank of District Veterinary Officer in 1950 in charge of an area about the size of Wales. On his return to this country Mr. Harrop took up an appointment as Lecturer in Animal Husbandry and Veterinary Hygiene at the Royal Veterinary College, London.

Artificial insemination has been extensively employed in the cattle industry for some years now as a means of improving the general standard of stock by only breeding from the best sires. More recently artificial insemination has been brought into use in the pig industry and it has been employed to a lesser degree in the poultry world, but up to date the breeding of dogs has not been carried out by artificial insemination other than on experimental lines.

The author's personal interest in this subject was first stimulated whilst working in Central Africa, where the necessity for artificial insemination in the dog manifested its need so clearly in cases where the owner of a pedigree bitch, wishing to mate it with a good dog of a similar breed, suddenly discovered that the nearest stud dog was several thousand miles away. The unfortunate owner had the choice of several courses (*a*) a stud dog could be imported—a very expensive procedure and often an unnecessary luxury for a small breeder; (*b*) the bitch could be sent away to be mated—the distance involved was tremendous and one had to consider the possible hazards of the journey and the complications of quarantine regulations; (*c*) the use of artificial insemination—were it available.

While working in the Animal Husbandry Dept. of the Royal Veterinary College, London, many queries on the subject of artificial insemination of dogs were received, chiefly from abroad, but no satisfactory answers could be given because of the difficulty in finding a suitable medium in which to preserve the semen for the necessary length of time. Work was therefore commenced in 1953 to carry out a thorough study of canine semen and to attempt to evolve some method whereby the semen of the dog could be preserved for a sufficient length of time as to render artificial insemination a practical possibility.

The art of artificial insemination in dogs is not a new one, for it was in 1780 that Abbé Spallanzani first recorded the successful artificial insemination of a bitch. During the next hundred years we did not hear much about artificial insemination until we come to the series of experiments carried out by Sir Everett Millais. These commenced about 1884 and continued for some twelve years, and he records how he successfully employed artificial insemination to produce puppies and, to prove his point, he deliberately crossed breeds such as Basset Hounds and Bloodhounds.

All this very early work was of an exploratory nature, and it is only within recent years that artificial insemination has been practised in order to effect matings that, due to certain conditions, would otherwise have been impossible. In such genuine cases the Kennel Club is prepared to register the offspring from such a union, provided it has been consulted prior to the event, and that it is satisfied that there is no possibility of fraud.

Artificial insemination in dogs has, up to the present, been subjected to a form of natural control, in that the difficulty of preserving the semen for any length of time has limited the widespread dissemination of semen from any particular stud, the survival time for normal dog semen being under 24 hours.

This most difficult obstacle has at last been overcome, and it is now possible to keep dog semen alive for several days, and for it to be still capable of fertilising a bitch at the end of that time. Without going into all the technical details as to how all this was accomplished, it is necessary to say that considerable research into the study of semen physiology had to be carried out first.

The first problem was the collection of the semen. Other workers in the past had collected by digital manipulation, but this method was soon discarded on both aesthetic grounds and also because of the unsatisfactory quality and quantity of the semen obtained. Several types of artificial vaginas were then experimented with —the method used for collection in other species—but none proved really satisfactory. In view of these shortcomings of existing artificial vaginas a new type had to be designed so that semen collections might be taken in as hygienic a manner as possible, and also to ensure that the whole of the ejaculate could be collected and not just part of it as often tended to occur when samples were taken by hand.

One important fact that emerged from this work was that it is now possible to give a reasonable opinion of a dog's fertility by taking a semen sample and subsequently examining it microscopically.

After having collected many samples it was observed that the ejaculate tended to come in three fractions (as described by Freiberg in 1935), and a simple technique was evolved whereby these fractions could be collected individually. This was a most important part of the work, for on examining these fractions it was observed that in only one fraction could live spermatozoa be seen.

Other characteristics of canine semen were more or less similar to those of other domestic animals, in so far as a microscopical examination shewed.

Preserving the semen was the next step. Relevant literature showed that the dilution and preservation of

canine semen had received little attention, and it was generally accepted that normal dog semen had a survival time of about 21 hours, although some workers stated that if the second or sperm-bearing fraction were isolated it could be kept for about 25 hours. Most of the diluents and preservatives used for bovine semen had been tried but had not proved successful.

Having this evidence to work on it was soon possible to try out various diluents with both whole and fractioned ejaculates, and after many such experiments it was discovered that by far the most successful diluent was heat-treated pasteurised milk. This possibly sounds rather a peculiar substance to use, but evidence of its value had been provided by American workers using bovine semen.

Using the second fraction of the ejaculate only and diluting 1 : 8 with heat-treated pasteurised milk, it was found that the semen would live for many days if stored at 4°C (the temperature of an ordinary household refrigerator).

All this work, while successful experimentally, had yet to be proved in a practical manner, and so experiments in actual artificial insemination were commenced.

The first experiment was to artificially inseminate a greyhound bitch with semen taken from a greyhound dog and which had been preserved and stored for four days at 4°C. The operation was successful, the bitch whelping two male puppies after an uneventful 64-day pregnancy.

The next step was to ascertain if this preserved semen would withstand the hazards of travel. To accomplish this a special polythene holder was designed to fit into a thermos flask, and to this a tube of preserved semen inside a protecting tube was clipped. The flask was then filled with crushed ice and the whole parcel was sent by rail to Glasgow where it was held for 24 hours and then returned. At the end of the three days and after having covered some hundreds of miles the sample was examined. The viability and the motility of the spermatozoa in this sample was identical to a portion of the sample that had been retained in London and stored at 4°C. This experiment was repeated on several occasions in both winter and summer and the results on each occasion were almost identical.

This experiment was now put to a practical test, and here we had the co-operation of the Animal Health Trust in the form of the Canine Research Station at Newmarket. Samples were sent down to Newmarket by rail where they were examined and pronounced suitable. In April 1955 a sample was sent down and was inseminated into a bitch in season which subsequently produced eight puppies after a 63-day pregnancy.

The actual technique of artificial insemination is relatively simple and can be carried out by any veterinary surgeon. All the apparatus required is a glass syringe connected by a piece of rubber tubing to a glass pipette. This pipette is inserted into the anterior vagina of the bitch and then the syringe full of preserved semen is connected up and the material injected.

The most important thing to remember is that the bitch must be at the correct stage of her oestrous cycle, or heat, the most favourable time probably being about the second day of acceptance, although individual bitches have their own best times which are usually known to the owner.

Encouraged by these successes a much more ambitious programme is at present in operation. Samples of canine semen, preserved in the manner described and packed in a thermos of crushed ice are being periodically flown to the U.S.A., where they are checked and examined by veterinary surgeons at Cornell University. This journey, which involves three changes of aircraft and covers many thousands of miles, is a severe test. The first sample that reached the American workers had been diverted to Newfoundland and was 63 hours old by the time it was first examined. In spite of this mishap, however, the report from our American colleagues was most favourable, the semen was in good condition when it reached them and, in their opinion, was capable of fertilising a bitch up to the time it was 173 hours old. Normally our samples reach them in just under 48 hours, and could be sent to Australia in about 3½ days.

Experiments are now in progress to try and inseminate a bitch in the U.S.A. with preserved semen sent from Britain, but it is too early for any results as yet.

What are the implications of all this work and of what benefit are they to dog breeders? The indications for the use of artificial insemination in the dog might be briefly listed as follows:

(*a*) When natural mating cannot be consummated—due to physical or physiological reasons.

(*b*) To replace natural mating when this is impossible due to geographical distance between stud and bitch—between one country and another.

(*c*) Increasing and extending the usefulness of a valuable proved stud—again the distance factor and also the fact that a single ejaculate could fertilise several bitches.

(*d*) As an aid in disease control.

Much work still remains to be carried out in this field. The "deep freezing" of canine semen has already been carried out, enabling samples of preserved semen to be stored for several months if not years. Sufficient work has already been accomplished however to make us realise the possibilities before us, such as the export of preserved semen from top-class dogs to the U.S.A. and other continents, the import of semen in a similar manner to this country, and the mating of dogs in Britain without subjecting the bitch to the hazards of travelling a long and possibly unfruitful journey.

(The author wishes to express his thanks to the Editors of the *British Veterinary Journal* and the *Veterinary Record* for their permission to allow him to use some of his work previously published in their journals for this article.)

THE INTERNATIONAL GEOPHYSICAL YEAR

MONTH BY MONTH

The IGY is perhaps the biggest scientific investigation ever launched.

While it lasts, from July 1957 to December 1958, "the most modern types of observation of many kinds . . . will be more widespread over the globe, and made with greater frequency, than ever before"—to quote Prof. S. Chapman, chairman of the organising body of the IGY Special Committee. Forty-three countries have already agreed to take part. Britain's programme alone, not by any means the largest, will occupy several thousand people. The scheme has been blessed by both President Eisenhower and the Pope, because it promotes international understanding and co-operation. It should effect a revolution in our knowledge of the earth's nature, as Prof. A. C. B. Lovell pointed out in DISCOVERY *of January 1956.*

DISCOVERY *considers it a matter of first importance to report regularly the manifold activities of this scientifically exciting enterprise, which at the middle of the 20th century will bring together research workers in a common project.*

The IGY has been planned since 1951, and July of 1957 will be the beginning of the eighteen-month International year. But for a scheme of this magnitude and this scope, preparations must be in hand far in advance of zero hour. Many of the instruments to be used had to be specially constructed, and some of these, as well as the teams to work them, had to be conveyed to, and installed in, the remotest parts of the globe. The present is therefore the building-up stage of the IGY.

The preparations for the main polar programme in the Antarctic had to start even earlier than for the others. These areas are normally uninhabited; what is still more crucial is that there is a bare ten-weeks period each year of relatively ice-free sea-approach when scientists can reach the Antarctic and set up their equipment. This, the first IGY report, therefore deals mainly with the progress of the Antarctic programme. This is appropriate enough, because an outstanding feature of the IGY is the intensive study of this region, "a part of the earth of which in some ways we know less than the Moon" (Prof. Chapman).

Arctic Conference

The organisation of the IGY programme is carried on by several working groups, each responsible for specific geographical regions. From May 22 to 25 the Arctic Working Group will meet in Stockholm to discuss the arrangements for geophysical measurements north of latitude 60°N. Fifty scientists from thirteen different countries are expected to attend. The nations sending delegates are Britain, the U.S.A., the Soviet Union, Canada, West Germany, France, Switzerland, Eire, Iceland, Denmark, Norway, Finland and Sweden. Britain's representative is Mr. J. M. Wordie, Chairman of the British National IGY Committee and an expert on glaciology. Britain is closely involved because measurements are likely to be made in the Shetland Islands. Besides, the opportunity for a major study of the Aurora Borealis affects the British observational organisation. This was set up by Mr. James Paton of Edinburgh, who is responsible for carrying out any recommendations on this subject made by the Stockholm Conference.

The Secretary of the conference is Dr. Nicolai Herlofson of Sweden. He was a lecturer in the Physics department at the University of Manchester immediately after the war.

There will be other conferences in the forthcoming months. The Third Conference of the Antarctic Working Group will probably meet in Paris in June. By then full reports will have come in from all the IGY Antarctic expeditions. Later in the summer a conference in Peru will consider the measurements to be made on the continents of North and South America.

Participating Countries

Argentina
Australia
Austria
Belgium
Bolivia
Brazil
Britain
Canada
Ceylon
Chile
China (People's Republic)
Czechoslovakia
Denmark
Finland
France
Germany (West and East)
Greece
Holland
Hungary
Iceland
India
Ireland (Eire)
Israel
Italy
Japan
Mexico
Morocco
New Zealand
Norway
Pakistan
Peru
Philippines
Portugal
South Africa
Spain
Sweden
Switzerland
Tunisia
U.S.A.
U.S.S.R.
Uruguay
Yugoslavia

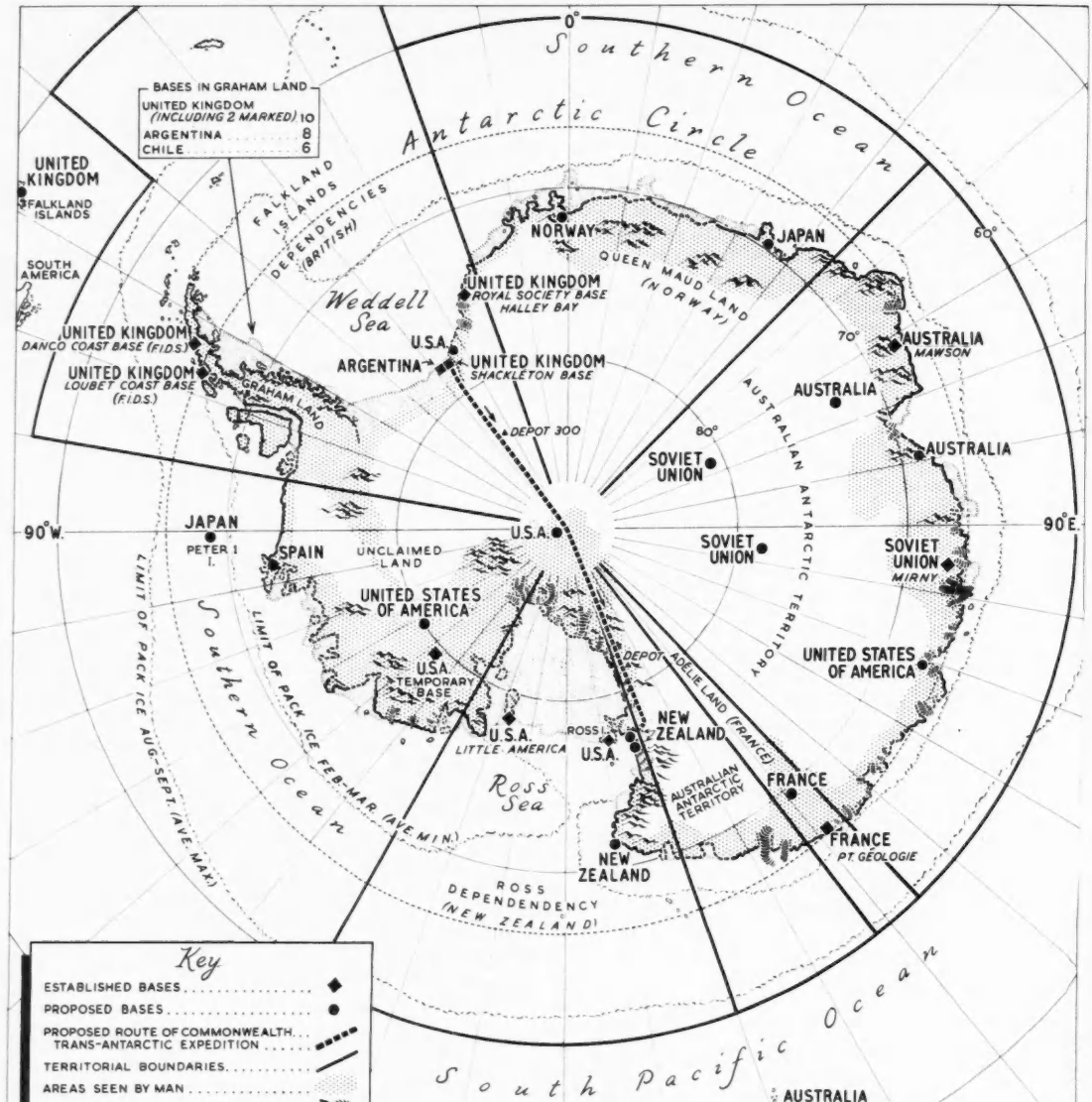
Twelve New Satellites

Twelve artificial earth satellites will be launched by the U.S. next year, according to BUP, Washington. Some of these "laboratories in space" are expected to remain up for a year or two, but not all twelve will be in operation at the same time.

Official details of the first satellite experiments to be made have been sent by the U.S. National IGY Committee to Prof. Chapman, Chairman of CSAGI (Comité Spécial de l'Année Géophysique Internationale). For brevity, only main points additional to, or different from, Prof. Singer's postulates in April's DISCOVERY will be given this month.

The first satellites will be launched from Patrick Air Force Base at Cape Canaveral on the east coast of Florida. A three-stage rocket will carry the satellite into its orbit about 300 miles up. Within three minutes the satellite will be 130 miles high and the first two rocket-stages will have been exhausted in attaining 11,000 m.p.h. The satellite will coast on to an altitude of 300 miles where the third rocket will impel it into its orbit, at 18,000 m.p.h.

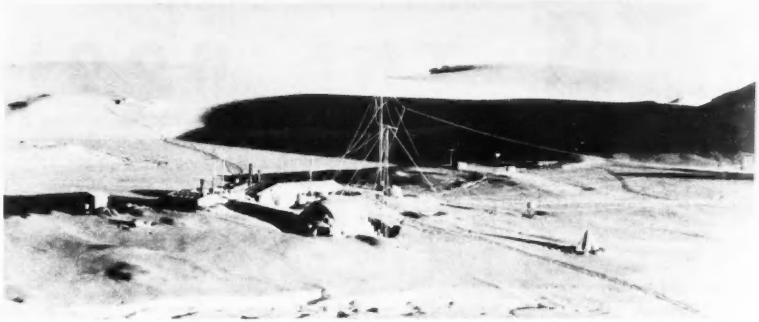
This satellite will be spherical in shape, about 30 inches in diameter. (A round satellite complicates the overall design but the shape is especially interesting for measurements of air density.) The sphere will weigh about 21½ pounds: half this is the weight of the instruments including telemetering systems. The satellite will travel at about 18,000 m.p.h. under its own momentum in an elliptical orbit (perigee, 200 miles —apogee, 800 miles from earth). It will circle the earth once in an hour and a half, and therefore sixteen times during



The most up-to-date map of Antarctica, specially drawn for DISCOVERY.

the twenty-four hours. The orbit's plane will be inclined 40° to the equator; this gives the satellite's path an apparent latitude ranging between 40°N and 40°S. The track will cross the U.S., Central and South America, Africa, southern Europe, the Balkans, the Middle East and part of the U.S.S.R., India, Pakistan, China, Burma, Vietnam, Malaya, Indonesia, Japan, Australia, and New Zealand. In good conditions, a satellite should be visible to the naked eye for about ten minutes as it passes overhead from horizon to horizon, the best time to see it being as it reflects the sun against a dark sky at dawn and dusk.

The first satellite will embody instruments for making eight types of experiments; on air density, the composition of the earth's crust, geodetic determinations, atmospheric temperature,



Nine instruments can be located in this picture of a typical FIDS meteorological base off the west coast of Graham Land. Besides two Stevenson screens, the nephoscope (like a garden rake), and the main radio aerial, a "dory" left behind by the 1934–7 British Graham Land Expedition, are visible in the snow (left); a "crater" beyond the mast indicates a shelter for the balloon hydrogen-generator; the shed by the nephoscope is for filling balloons; the "sheep-fold" in the right distance is for dogs.

atmospheric pressure, meteorites and micro-meteorites, ultra-violet solar radiations and cosmic rays. Other experiments are planned for later satellites.

14 Savants and 350 Tons of Instruments in Adélie Land

The most modern and the best-equipped of French polar laboratories will soon be up at Pointe Géologie in Adélie Land. Fourteen experts will live and work there for a year under the leadership of Robert Guillard.

The polar ship *Norsel* which conveyed the party to the base has now returned to Tasmania. Bertrand Imbert and Paul-Emile Victor, the world-famous explorers, returned with the ship.

Three hundred and fifty tons of scientific equipment and stores were unloaded at Pointe Géologie without a single mishap, although the weather was bitterly cold and the work was hindered by blizzards. The operation was greatly eased by the overhead railway, installed beforehand, which successfully handled even the heaviest loads.

The foundations of two large metal huts are now ready on the top of the Isle of Petrels.

FIDS Scientific Bases Now Total Ten

News reached London at the end of March that two new British Antarctic bases off the west coast of Graham Land have been established. This extends the scientific work of the Falkland Islands Dependencies Survey to fresh areas, and brings the total of FIDS bases up to "normal expansion". All these FIDS bases make other observations besides their main survey work: all will be contributing to the IGY programme.

One of the new bases, "Loubet Coast", is just inside the Antarctic Circle; the other, "Danco Coast", is just outside it, both on islands near the Coasts. The Danco Coast Base is in fact less than a mile from Graham Land and when this narrow stretch of water freezes over in a few months' time there will be ready access to this uncharted region. The Loubet Coast Base was set up on one of a group of six previously uncharted islands and has "the best anchorage in the Dependencies" according to the Master of the Royal Research Ship *John Biscoe*, which carried the base party. The R.R.S. *Shackleton* carried the other party.

This is the *John Biscoe*'s last voyage for FIDS. After nine years with the Survey she will return to Britain shortly to be sold. Her name will be transferred to a new ship of greater range and cargo-capacity.

Geologists, surveyors, wireless operators, trained mountaineers and carpenters form the staffs of the new bases. Total complement of the bases together is fourteen men. Loubet Coast Base will also be making meteorological observations.

The base-leader in each base is appointed magistrate and an official post office is inaugurated.

The value of this training may be judged by glancing at the previous careers of those now engaged in the several British expeditions to the Antarctic. The leader of the British Trans-Antarctic Expedition, Dr. Fuchs, has been head of FIDS Scientific Bureau for some years; the leader of the Royal Society Expedition, Surgeon Lt.-Cmdr. Dalgleish, was a member of FIDS from 1954–1955. Eight other men with these expeditions are also FIDS-trained.

Halley Bay Named

Last news before going to press is that names have been given to the bay at which the Royal Society Expedition's Advance Party disembarked, and to the base established near by. It has been agreed that the bay shall be called Halley Bay, after the famous astronomer and pioneer geophysicist; the base will be called Royal Society Base. This was the recommendation of the Council of the Royal Society. It is interesting to be reminded that Halley was elected a Fellow of the Royal Society at the age of twenty-two, and became its secretary in 1713.

During the last fortnight of March, London was talking almost nightly with the Advance Party at Royal Society Base by direct radio-telephone. Morse contact was first established on March 13, but when an attempt was made to switch to "voice" it soon became apparent that there was a fault in the system. The Advance Party detected the fault on the 15th and had completed the rewiring and repair of their transformer by the 20th, when satisfactory "voice" contact both ways was made. BBC and GPO engineers in London said it "reflected great credit on expedition members that they could find and repair this serious breakdown with the facilities they had". The transmitter in Antarctica operates on 17.515 kilocycles with only 250 watts. Recordings from the transmissions were broadcast by the BBC on March 27 and April 1.

Trans-Antarctic News

Dr. Fuchs and Sir Edmund Hillary, leaders of the British Trans-Antarctic Expedition and the New Zealand Trans-Antarctic Party respectively, reached London in *Theron* on March 22. They had left Shackleton Base on February 7.

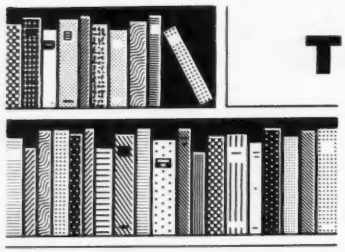
Dr. Fuchs said that though the expedition's object is not primarily scientific, some topographical, geological and meteorological observations will be made and a geophysicist is to accompany the party across the continent to measure the ice-cap thickness. When asked whether any astronomers were taking part in the expedition, Sir Edmund drew laughter with his remark that "in summer it's light all the time—which rather restricts astronomy!"

By selling tadpoles at tuppence a time, two New Zealand boys from near Wellington have raised the sum of £2 10*s*. for the New Zealand part in the Trans-Antarctic Expedition. The Appeal Committee has announced that this "tadpole money" will be put with other contributions for the purchase of scientific equipment for the expedition. (UNESCO.)

Postscript—Personnel

The British Programme for the IGY depends to a large extent on securing sufficient trained personnel to man the stations that will be working in Great Britain, the Colonies and Antarctica. Interested persons are asked to communicate *before May 31, 1956*, with the Assistant Secretary, The Royal Society, Burlington House, Piccadilly, London, W.1.

FIDS is also at present recruiting suitably qualified personnel for the coming Antarctic season. Those interested should write to FIDS (Rear Base), 4 Millbank, London, S.W.1.



THE BOOKSHELF

I Looked for Adam

By Herbert Wendt. Translated from the German by James Cleugh (*London, Weidenfeld & Nicolson, 1955, 556 pp., 48 plates, 30s.*)

Man in Search of His Ancestors

By Andre Senet. Translated from the French by Malcolm Barnes (*London, George Allen and Unwin, 1955, 274 pp., 21s.*)

Pope's injunction must have been taken more seriously recently than for many years, for there has been quite a series of books on man. Among them are two general and semi-popular volumes of outstanding interest. It is helpful that though they inevitably cover much of the same ground they are written from different points of view. The first of them is Herbert Wendt's *I Looked for Adam*. This is a large book that diverts and instructs, intrigues and angers, though the complaints are not against the author or the publisher but against powers and principalities long gone. The story unfolded is of the tangled web that has been woven by the constructors of the family tree of man, using both terms in the widest sense. A fascinating study, for the story of man is not merely the interpretation of evidence, as provided by fossils and comparative anatomy, and the consideration of problems of geographical distribution, but also the history of man's development of an interest in his lineage and his struggle for freedom to pursue such a study.

The fight for the recognition of fossils as acceptable evidence was virtually a challenge to the veracity of the story of Genesis and many a proud and able man could not face taking such a step. Gradually, throughout the last three hundred years, discoveries have made the facts of geological history indisputable, though it is less than a century since some of these facts have attained general acceptance. Herr Wendt traces this fossil and human story, with its trial and error, its confusion, science and non-science. Written with a wealth of anecdote, much of it new, this is an ideal bedside book for the amateur naturalist and a volume for the serious consideration of the student of geology, zoology and anthropology. The fight for freedom is only feebly recognised today in an age when some freedoms have already been lost for many, so that there are other lessons than anthropological to be learned from a study of these pages.

The second volume is a French contribution on much the same theme, though dealing rather more fully with the French share in this work. *Man in Search of His Ancestors* is written by André Senet who speaks with all the authority of a member of the stimulating Musée de l'Homme in Paris. His book is not quite so long, his story not quite so detailed, but it is interesting and informative in the first and the third sections where he deals with the disciplines of his choice. In order, however, to give some breadth and depth to his argument there is an intermediate evolutionary section, entitled "Our Ancestors the Fishes", which relates the rise of the vertebrates, and especially the fossil reptiles. And this part somewhat mars the whole, for though the section is brief it contains a remarkably full quota of errors of fact.

None the less, with that caution duly administered, the general reader and the student can enjoy the major portion of the book. Taken together these two books will give any student a good general knowledge of the rise of vertebrate palaeontology, and they are valuable too in that they place the rather untypical study of human remains on the pedestal of vertebrate evolution where it indubitably should rest. The difficulty of human palaeontology lies in the confusion of nomenclature that must result from an aggregati on fragmentary materials, not always directly comparable, and often with undue importance attached to the find by its discoverer or describer. There is also the lack of an acceptable and generally applicable definition of man, for the transference of that term often takes with it, in the mind of the general reader, quite separate properties that should not be applied indiscriminately to specimens of fossil "men".

Discussions such as these German and French contributions help to place the subject of man in its true perspective, quite apart from the historical and biographical interest that these particular surveys so admirably display.

W. E. SWINTON

The Old Shrub Roses

By Graham Stuart Thomas, F.L.S. (*London, Phoenix House, 1955, 224 pp., 32s. 6d.*)

Since the 1930's the old-fashioned shrub roses (as distinct from modern varieties of hybrid teas, floribundas, etc.) have become popular again. The author of this book is director of a well-known English nursery which contains the most complete collection in the world of the old roses and he has long been recognised as a leading authority on the subject. Graham Thomas is a horticulturist not a botanist. It is therefore the more pleasing to record that *The Old Shrub Roses* is accurate as regards plant names; and it is very carefully indexed and has an adequate bibliography.

The history of these roses and their cultivation in the modern garden are discussed at some length. There are extensive notes on individual species, hybrids and varieties, all based on personal knowledge. The late Dr. C. C. Hurst's notes on the evolution of garden roses are included, as well as genealogical tables by Gordon Rowley of the John Innes Horticultural Institution.

The layout and typography are excellent. There are numerous monochrome illustrations, and eight pages of colour plates. The latter vary in quality, the only weakness in an otherwise outstanding work. I hope this book will find a place not only on the shelves of all in the least degree interested in the old roses, but also in every library and scientific institution where horticultural books are included. N. P. HARVEY

Earth Satellite

By Patrick Moore (*London, Eyre & Spottiswoode, 1956, 128 pp., 15s.*)

Satellite vehicles are undoubtedly stimulating scientific thought and will continue to do so with added effect when the exact plans for the American experiments are released and when it becomes generally known what the orbits will be and how much payload may be carried.

This book summarises the historical background of rocketry and outlines high-altitude studies which have led to the possibilities of and the demand for the establishment of a satellite. As such, it provides a good introduction for the newcomer to astronautical ideas. Those who are well read on the subject may find the book a little disappointing, because only about one-third of the text really deals with the subject of the title. Yet these forty-odd pages do contain a fair appraisal of the satellite projects and reasonable suggestions of the type of scientific work which may be accomplished with the aid of such vehicles. The final chapters indicate how manned satellites could lead to space flight.

Mr. Moore seems to have missed a point, however, when he dismisses all solid-propellant rockets as useless for high-altitude work. Extensive American and British upper atmosphere research is currently planned to use solid-propellant rockets, while liquid-propellant high-altitude vehicles rely on solid-propellant boosters. For synoptic work—which seems to be the type of

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The Journal of British Nuclear Engineering

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experiment demanded for further progress in this field—the solid-propellant rocket scores over its liquid-propellant counterpart both in ease of handling and in cost. It can, moreover, nowadays have a programmed thrust.

Details are given of the MOUSE project of Dr. Singer which probably represents the closest approach to the plans for the satellites which will be launched from Canaveral, Florida, during the International Geophysical Year. It is of interest to find that the author concludes that a small telescope will be adequate for observing the satellites. Unfortunately the probable orbits mean that they will move in paths which will prevent their observation from these high latitudes.

Throughout the book the author shows detailed astronomical knowledge. A number of suggestions are made of ways in which astronomical problems might be tackled and solved by artificial satellites and their probable developments.

The literary style makes easy reading, as with Mr. Moore's other books, but surely at the price charged the publishers could have included some upper-atmosphere rocket photographs.

ERIC BURGESS

Surveying Instruments, Their History and Classroom Use

By Edmond R. Kiely (19th Year-book of the National Council of Teachers of Mathematics, Teachers College, Columbia University, New York, 1947. *Distributed in England by W. Heffer & Sons, 411 pp., 21s.*)

Although first published nine years ago, this book deserves the increased popularity it has recently found in England. It is the best treatment in English of the historical design of scientific instruments, and its scholarly and full bibliography makes it an indispensable work of reference.

This book is of much wider importance than its title might suggest. It gives a very competent analysis of the evolution of instruments during that period of the Scientific Revolution when instruments and quantitative experiments were such a vital factor. The sections purporting to show how useful this study is in the modern teaching of elementary mathematics are secondary, and seem to serve the purpose only of making this an acceptable book for the special series in which it was first published.

Dr. Kiely is to be congratulated on his treatment of the literature, which is by no means readily accessible even in big national libraries. Unfortunately there is only one fine collection of antique scientific instruments in the whole of the United States (at the Adler Planetarium, Chicago) and the author has not used material from it. There are illustrations from original texts, but the half-tone reproduction is poor. The student in England, with many readily accessible collections of antique instruments in the chief science museums, will find this book invaluable for an understanding of scientific historical documents.

Concentration on the scientific design of instruments has led to some omissions. There is too little technological consideration of instrument-making and too few descriptions of personalities of little-known instrument-makers and mathematical practitioners responsible for the tools of experimental science. This book must nevertheless be considered a standard work and a source of information not accessible elsewhere. DEREK J. PRICE

Cocoa

By D. H. Urquhart (*Tropical Agricultural Series; London, Longmans, Green, 1955, 35s.*)

It is fitting that an up-to-date and comprehensive work on the cultivation and production of cocoa should now appear. In recent years much research has been devoted to this important crop and substantial advances in knowledge made in several different fields.

The popularity of chocolate among the people of the world continues. With a rapidly rising world population and a higher standard of living in many countries, the demand for chocolate and hence for the cocoa bean is likely to increase still further. Unfortunately diseases of the cocoa tree have seriously reduced production in some countries, but this has been or is being offset by cocoa planting in other parts of the tropics.

The author has had long experience of the cultivation and production of cocoa in West Africa, having been Director of Agriculture of the Gold Coast. He also has first-hand knowledge of cocoa in other parts of the tropics.

All aspects of cocoa cultivation and production are covered. Some of the chapters have been written by other writers, specialists in their respective fields. The chapter on virus diseases of cocoa is bound to interest virus workers in other fields.

The book is very well produced, with ten plates in colour and eighty-seven in black and white.

F. N. HOWES

Ball's Popular Guide to the Heavens

Fifth Edition, edited by Ernest Agar Beet (*London, George Philip, 1955, 84 pp., 83 plates, 30s.*)

The fourth edition of this book, edited by the late Rev. Dr. T. E. R. Phillips, appeared in 1925, and while the text in the fifth has not been greatly altered, amendments have been made to statements which "in the light of the present day are no longer correct". A few words have been added "as a hint to the direction which new knowledge is taking". The author is Secretary of the British Astronomical Association and on the staff of the Nautical College, Pangbourne. Among the revisions may be noticed: the new eclipse map replacing the old one that expired in 1950; changes and additions in the star maps, and revisions in separation of double stars; two additional photographs of sunspots taken on February 5 and 9, 1946, shown in plates 12 and 12a; planetary phenomena between 1945 and 1970 given in tabular form on p. 38; additional photographs of Morehouse's Comet and a photograph of Whipple's Comet, 1942.

An "Index to the Planets" includes the planets Venus, Mars, Jupiter and Saturn; the planets' times of rising and setting, the time of crossing the meridian, and the best times of the year for observing it, can be determined up to the end of 1970. Nineteen plates of the moon show our satellite between the third and fourteenth day, the latter of course at full, with key maps explaining the chief markings. Other plates show special parts of the moon; and four charts, one for each quadrant, are explained in the key maps. Numerous star maps for different times of the year, diagrams explaining the seasons, tides, revolutions of the planets, phases of the planets, photographs of nebulae, etc., all add to the interest and value of this work.

M. DAVIDSON

Introduction to Chemistry

By Howard L. Ritter (*New York, Wiley; London, Chapman and Hall, 1955, 649 pp., 52s.*)

The author claims to be offering chemistry not as an encyclopaedic catalogue of facts but as a cultural discipline. It is certainly easier to see from this book than it would be from its British contemporaries that the author is "having a grand time in his study of chemistry, learning something of how the world works". History is almost entirely discarded and the whole subject is treated in three parts. First, the nature of matter is investigated, including kinetic-molecular and atomic theories and the structure of atoms. Secondly, chemical reactions are dealt with, including the formation of compounds, ionic phenomena, oxidation and reduction, energy effects accompanying reactions, and the periodic classification of the elements. It is only then that descriptive chemistry is brought in, though it takes up nearly half the text. Here are introduced organic as well as inorganic compounds, colloids, the chemistry of life-processes and radioactivity. To plunge straight into learning about energy and atoms is now thought preferable to the more traditional approach, in which a study of the chemists of the past led the student along the route their predecessors had travelled. The matter presented is not so very different from that given in a corresponding British textbook, but there is an unusually pleasant air of readability. Illustrations are comparatively few, but are of a size

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which exaggerates their importance. No ordinary chemical apparatus is illustrated, nor are any laboratory experiments described, only their principles. The questions at the end of chapters must have caused the author some worry, since test papers are not readily put into palatable form. He has done his best, however, by asking quiz questions in which blanks are to be filled in or a true-or-false decision taken. Other questions are related to everyday life, and mostly they are well worded to stimulate the student. They give him but little encouragement merely to reproduce what he has just been told in the chapter. Surprisingly, the exercises peter out after the nineteenth chapter, leaving the last nine chapters questionless. This book could easily find a place as a first-year college textbook on this side of the Atlantic. Although its order is unconventional, most of the necessary material is present and the style deserves high praise. This book is in no sense popular scientific writing, though it comes near to achieving similar readability. Any intelligent person with only little previous chemical knowledge could follow the argument without requiring help from a lecturer.

W. ASHWORTH

Organic Insecticides, their chemistry and mode of action

By R. L. Metcalf (*London, Interscience Publishers, Ltd., 1955, 392 pp., 68s.*)

Despite their small size insects possess many counterparts of the very much larger animals of the vertebrate classes. Despite an enormous diversity of external morphology, habitat, and behaviour they possess inter-similar feeding, digestive, excretory, blood, heart circulation, and respiratory mechanisms. They possess neuromuscular processes of detection and locomotion equivalent and sometimes remarkably similar to those of higher animals. Most striking perhaps is the similarity of their biochemistry of respiration, nerve, and muscle function to that of vertebrates. Many drugs and poisons induce responses in insects which differ quantitatively rather than qualitatively from those induced in higher animals, including man. Being small, often pestiferous, their use as experimental animals rarely inspires any human sentiments of disapproval. They are rapidly and easily bred in large numbers in the laboratory. It is not surprising, then, that insects are being used increasingly as experimental material by the comparative biochemist, physiologist, and toxicologist. In this context Dr. Metcalf's book is a little disappointing. Considerable sections are a dreary catalogue showing the relation between "lethal dose—50" against various insect species and the various analogues and derivatives of insecticides or potential insecticides. While the importance of these data is unquestioned, they have been acquired more in the empirical search for better insecticides than in the study of the mode of action of insecticides. This criticism notwithstanding, one section (Chapter III) briefly but clearly discusses the significance of optical and geometrical isomerism in the toxicity of the pyrethroids and does some credit to the patient work of the American and English teams in this field. Dr. Metcalf recognises the importance of possible differences between the physiology and biochemistry of insects and mammals in the development of more selective insecticides (e.g., p. 297) but nowhere does he critically examine the evidence for or against such differences. There must be few active research workers more competent to do this than Dr. Metcalf himself. It is hoped, therefore, that in a future edition Dr. Metcalf will expand a little on the comparative biochemistry of insecticidal action at the expense of the present toxicity-chemical structure data. In this way his book will appeal to the student of comparative biochemistry and physiology as well as to those concerned with insect control.

The book deals systematically with organic insecticides and acaricides grouped according to their chemistry. Each chapter considers, seriatim, chemistry, structure-toxicity relations, "mode of action", and mammalian toxicity of a particular group. Two special chapters are devoted respectively to joint action and synergism, and to insect "resistance" to insecticides, the latter being a very useful though uncritical review of the position to 1955. Fumigants or volatile insecticides such as the halogenated hydrocarbons, ethylene oxide, hydrogen cyanide, etc., are not considered. Dr. Metcalf's book is an authoritative and up-to-date summary of the relative toxicities to insects and to mammals of organic contact insecticides and their chemical relatives. It also includes brief descriptions of the biochemical and physiological effects of these substances, and it will find its place on the shelves of all entomologists and chemists concerned with the fundamental problems of insect control.

F. P. W. WINTERINGHAM

Contributions to Plant Anatomy

By I. W. Bailey (*Waltham, Mass., Chronica Botanica, 1954, 259 pp., 23 plates, 60s.*)

When a scientific author undertakes to reprint, substantially in their original form, the principal results of a long life spent in research, he places himself in a peculiarly vulnerable position, for he will draw down upon any historically inevitable shortcomings of his earlier work the attentions of an unsympathetic younger generation complacent in that wisdom which comes after the event. It is a measure of Prof. Bailey's stature that even the oldest papers in this collection make negligible demands upon the reader's historical imagination and still appear altogether modern in style and approach.

Selected items from the author's immense output have been grouped according to subject-matter, the general theme being the "successive attempts between 1909–1953 to bridge the gaps between Plant Anatomy and other fields of scientific endeavour".

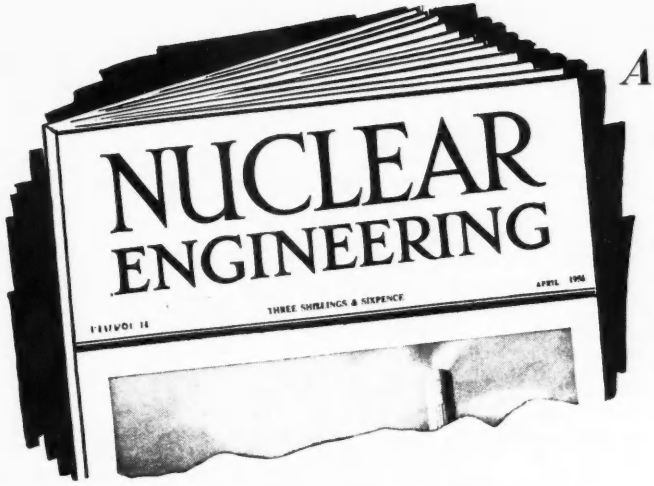
The book will merit a place in every botanical library because of its first two sections, which constitute a major addition to the classical literature of the subject. The well-known papers on cambial anatomy and cytology here lead on naturally to a group of chapters on the fine structure of cell walls. Besides presenting a splendid series of original observations, the writer has accomplished a wholesale demolition of the many pre-existing errors and fallacies which he found cluttering his field of discourse. As is so often the case with works of this calibre, the magnitude of the achievement is partly disguised by the apparent ease with which the thing has been done. Technical details are here kept firmly in the background, and untruths which have been expounded at tedious length are dismissed in language which is admirably brief and simple. In a science where so much of the literature seems to have been written by timid young research students, eagerly hedging every statement with conditions, dutifully quoting every incompetent nonentity who ever wrote a paper, and terrified of omitting the least triviality of technique, it is a relief and a pleasure to encounter a writer with such an excellent style and so many good things to say.

The work on cell walls occupies a special position because it is the best account, at least in English, of the state of knowledge prior to the development of electron miscroscopy. As such it may fulfil an urgent need of the present time by helping to keep alive an interest in the older methods of chemical and physical investigation until the novelty of the newer instrument has worn off. The author's observations on the finer visible markings and on the action of fungal enzymes are particularly interesting and important.

The professor's critical faculties have ranged with considerable effect into a number of other fields, as seen in two chapters dealing with the identification of fossil woods and with the theories of symbiosis between certain ants and the plants on which they dwell.

Naturally the book is not without its weaknesses. One strangely incongruous feature is a long chapter on the organisation of forestry research in America. This has no obvious relevance to the title of the volume, and would appear to possess only ephemeral interest, even for the American reader.

There is much to criticise also in the two sections devoted to the morphology of vessels and tracheids and to the



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Professor Piccard's book, though it takes the reader from the stratosphere to the floor of the ocean, is primarily the story of the development of the stratospheric balloon and the adaptation of the principles to the submarine bathyscaphe. He explains, in language that any reader of popular science can understand, all the difficulties that had to be surmounted in achieving mobility while combating the terrific pressures involved, showing in satisfying detail how all the difficulties were overcome; and relates his own experiences in the heights and the depths, experiences which, in spite of all his precautions and calculations, were not lacking in dramatic excitement.

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CASSELL

taxonomy of Degeneriaceae and allied families. The factual material, which is uniformly excellent, is here mingled with the phylogenetic speculations with which in recent years the author has been increasingly preoccupied.

It is now almost an established psychological law that any botanist who contemplates with sufficient intensity a selected gynaecium will sooner or later recognise in it the Archetype of All Carpels, and will abandon the classical theory in favour of the new truths which have been revealed to him. In obedience to this rule Prof. Bailey has enriched the flow of phylogenetic thought with the "conduplicate" carpel. Admittedly the concept is not so weirdly improbable as some of its competitors, but its prospects of gaining general acceptance do not seem good.

In the chapters on the evolution of vascular tissues the author has adopted wholeheartedly the principle (which is not new) that evidence drawn from tracheids and vessels is exempt from many of the normal uncertainties of phylogenetic inference. He has conducted his arguments with great vigour and skill, but as is usual in such cases he has not allowed for the existence of other schools of thought which would say that some of his conclusions are absurd, and that he has disapproved by *reductio* the premises from which he began.

Despite its faults, this book will stand as a major landmark in the history of the subject. K. J. DORMER

Making and Using a Telescope

By H. Percy Wilkins and Patrick Moore (*London, Eyre and Spottiswoode, 1956, 160 pp., 12s. 6d.*)

There are plenty of books on popular astronomy and no shortage of handbooks for the already practising amateur, but until now there has been no publication designed to help beginners build and use a telescope. Now two of the most friendly and competent enthusiasts have set out all the essential elements needed for building and using inexpensive telescopes and other astronomical equipment. They explain how to make a "tin-can" planetarium and how to design a Dialyte type telescope. There is enough about stellar and planetary observing to convince the convert that his labours will be valuable and interesting; and there is a commendably select bibliography. Some remarks on astronomical societies are appended.

The historical treatment is perhaps a little facile, but this is unimportant. In Fig. 5, p. 28, the axes of worm and worm-wheel have been wrongly drawn as parallel instead of perpendicular.

Sixth form libraries ought to have a copy of this book, and it can be highly recommended to any handyman, man or boy, not quite satisfied with a merely passive appreciation of astronomy.

DEREK J. PRICE

Atom Harvest

By L. Bertin (*Secker & Warburg, 1955, 20s.*)

Mr. Bertin has attempted to do for British Atomic Energy what was done for America in Mr. Gordon Dean's *Report on the Atom*. His book is written without Mr. Dean's first-hand knowledge and has too much the air of propaganda. There is no reference to American post-war developments. I wonder whether Mr. Bertin was wise to raise the controversy about the breaking off of war-time relationships between U.S. and British projects. I myself wrote about this several years ago in the American *Bulletin of the Atomic Scientists*, and certainly the severance was an acute disappointment to all British scientists who had worked with their American colleagues. In many respects it caused the British projects to start under a severe handicap, but on the other hand it did mean that we had to think things out for ourselves, and this may have been an advantage. If we had known all about the Hanford water-cooled reactors, should we have built the gas-cooled Windscale plant which led to the gas-cooled Calder Hall reactors?

Mr. Bertin appears to suggest that there has been no atomic co-operation since the war, a conclusion easily disproved by the visits of British atomic energy staff (including myself) to secret projects in the U.S.A. The Chalk River reactor was not built without advice from reactor experts in the U.S.A. It is true that co-operation has been by no means full, and it has been very sparse or non-existent in some projects, but it has not been as bad as Mr. Bertin seems to think. I do not believe his suggestion that the McMahon Act (which made full co-operation impossible) was due to a dollar complex, since this is belied by U.S. generosity in other fields. It was more probably due to a misplaced fear immediately after the war that a Socialist Britain would go "red" along with the rest of Europe, coupled inconsistently with an idealistic view that Atomic Energy ought to be controlled by UNO.

The book gives an up-to-date and accurate account of British achievements in Atomic Energy. But technical matters are described in terms too vague for the technical reader, yet I fear they must often be incomprehensible to the layman. The author includes a number of chatty accounts of Atomic Energy personalities.

I think, and Mr. Bertin thinks, that the post-war achievements of British Atomic Energy are very great. I believe they deserve a rather different sort of book. Harwell and Risley have both published excellent reports in semi-technical terms. It would be a good thing if these could be brought up to date now that so much material has been declassified and reported on at the Geneva Atomic Energy Conference of last August. H. W. B. SKINNER

From Simple Numbers to the Calculus: Mathematics for Everyone

By Egmont Colerus, translated by B. C. and H. F. Brookes (*Melbourne, London, Toronto, William Heinemann Ltd., 1955, vol. XI, 255 pp., 73 diagrams, 12s. 6d.*)

The translators of this book reduced the length of the original German by about one-third, hoping thus to make it more attractive to English readers. It deals with a heterogeneous collection of mathematical subjects such as the scales of notation, equations, including quadratics but not cubics or biquadratics, permutations and combinations, indeterminate equations, imaginary and complex numbers, etc., and the usual earlier stages of algebra. There is a brief treatment of trigonometry with an explanation of the six functions and their application to the determination of the height of a mountain. Readers may find the chapter on functions of angles difficult, especially as a formula for the calculation is given without any proof. The same remark applies to chapters on calculating the lengths of curves and Archimedes' quadrature of the parabola, a problem which is incomparably simpler by integral calculus.

The same criticism applies to other parts of the book, and its chief fault is that it attempts too much. Some readers, however, may benefit by new presentations and expositions. The author shows originality, one instance of which is the mechanical device explained in Chapter XVIII on "Algebraic Functions", which should assist beginners in the differential calculus. M. DAVIDSON

New Booklets

A 39-page illustrated booklet explaining the principles of interference microscopy and describing the results obtainable with the Baker interference microscope is available from C. Baker of Holborn Ltd., 244 High Holborn, London, W.C.1.

A new pamphlet issued by Crompton Parkinson Ltd., describes the part that C.P. electrical equipment and instruments play in technical educational establishments throughout the world. Novel ideas and methods of mounting and adapting instruments and equipment for test purposes, in laboratories and demonstration rooms, are clearly illustrated.

Copies can be obtained from: Crompton Parkinson Ltd. (Ref. SPJ), Crompton House, Aldwych, London, W.C.2.

Chapman & Hall Ltd. has published a brochure on books covering all phases of corrosion from packaging to paint.

Sondes Place Research Institute (Dorking, Surrey) has issued a booklet which describes the facilities for sponsored research which it has built up. Since 1947 it has handled over 1200 industrial problems.

"Shell Films 1955" is the title of a complete catalogue of Shell Films

available to all organisers of film shows for educational groups and those seeking visual aids for talks, lectures or symposia, who apply to: Shell Petroleum Company Limited, Public Relations Department/W, 1 Kingsway, London, W.C.2.

Guide to Instrumentation Literature is published by the U.S. National Bureau of Standards (circular 567) at $1. Over 1200 references are listed, including abstract journals, bibliographies, books on technology, directories of manufacturers, periodicals, patents, etc.

The first report of the Joint FAO/WHO Expert Committee on *Meat Hygiene* has just appeared at 3*s.* and may be obtained from H.M.S.O. It includes plans for design of abattoirs.

France Moves Forward is an attractively illustrated booklet giving a general view of the French industrial scene today. It is published in France by "La Documentation Française".

A brochure designed to provide information about the *Organisation for European Economic Co-operation*, its origins, present structure and methods of work, is published from 2 Rue Andre-Pascal, Paris.

A pamphlet on *Plant Growth and the Weather* by F. L. Milthorpe, his inaugural lecture as Professor of Agricultural Botany at the University of Nottingham, is available from the University at 1*s.* 6*d.*

The National Institute of Adult Education has published its conference addresses for 1955 in the form of a pamphlet entitled *Adult Education and Working Life*, price 2*s.* 6*d.* There are articles on various aspects of liberal education in our technical age.

The East Africa High Commission publishes a record of Research for the period January 1, 1954, to June 30, 1955, under the title *East African Agriculture and Forestry Research Organization*, with sections on physics in agriculture, soil science, plant protection, forestry, etc.

CERN (European Organization for Nuclear Research) publishes a small booklet commemorating the laying of the foundation stone in Geneva on June 10 and 11, 1955, with photographs of the signatories and their speeches.

The *Smithsonian Institution Report* for the year 1955 is now available from the U.S. Government Printing Office, Washington.

Vol. 5, No. 2, 1955, of the *Quarterly Journal of the Colonial Products Laboratory* deals with colonial plant and animal products and includes sections on tanning materials, pyrethrum, preserved ginger, hardboard from tropical timbers, and oils from Rhodesia, Tanganyika and Cyprus. It is available from H.M.S.O., price 5*s.*

The *Agricultural Research Council* has issued a booklet giving details of the training grants, research studentships and fellowships offered for 1956. It may be obtained free of charge from the Secretary to the Council, Cunard Building, 15 Regent Street, London, S.W.1.

Three booklets have been received from the Air Ministry: one on *Barometric Changes and the Efflux of Gas in Mines* by C. S. Durst, one on *Rainfall of Depressions which Pass Eastward over or near the British Isles* by J. S. Sawyer, and one on *Some Features of Jet Streams as Shown by Aircraft Observations* by R. Murray. All are available from H.M.S.O., the first two at 9*d.* each, the latter at 4*s.* 6*d.*

Bulletin No. 277 of the Commonwealth Scientific and Industrial Research Organization, Australia, deals with laboratory testing with termites for evaluating the resistance of timber, timber preservatives and other materials against termite attack.

The Report of the Nature Conservancy for the year ended September 30, 1955 (H.M.S.O., 4*s.*) contains a full section on the scientific work to conserve woodlands, mountains and moorlands, grasslands, coast areas, etc., with photographs.

An article by W. A. Krehl on the nutritional significance of the carbohydrates has been published by Borden's Review of Nutrition Research, 350 Madison Avenue, New York.

The Aluminium Development Association's Bulletin Nos. 2 and 21 have been received. The former deals with the properties of aluminium and its alloys, the latter with aluminium in contact with other materials (price 7*s.* 6*d.* and 2*s.* respectively, from the Association at 33 Grosvenor Street, London, W.1).

FAR AND NEAR

New Fellows of The Royal Society

The following scientists have been elected Fellows of the Royal Society:

NORMAN PERCY ALLEN, Superintendent, Metallurgy Division, National Physical Laboratory, Teddington, Middlesex. For his work on alloy steels, their transformations and their engineering properties.

JOHN FLEETWOOD BAKER, O.B.E., Professor of Mechanical Sciences, University of Cambridge. For his experimental and theoretical investigations of steel structures and for services to education in engineering.

RICHARD MALING BARRER, Professor of Chemistry, Imperial College of Science and Technology, London. For his work on the mechanism of adsorption and diffusion of gases in solids and the problem of molecular sieves in zeolite minerals.

ROBERT BROWN, Head of Agricultural Research Council Unit of Plant Cell Physiology, Oxford. For his work on germination of parasitic seeds and isolation of germination hormones, also for studies of factors involved in cell division and development.

JOHN ALFRED VALENTINE BUTLER, Professor of Physical Chemistry, University of London. For this work on thermodynamics, and the application of physical techniques for the solution of problems of molecular structure of deoxyribonucleic acids.

DENNIS GABOR, Mullard Reader in Electronics, Imperial College of Science and Technology, London. For his work on transient electric phenomena, electron microscopy, the theory of communication and the electric arc plasma.

HANS GRUNEBERG, Reader in Genetics, University of London. For his investigations into the expression of genes during development in mammals.

CHARLES SKINNER HALLPIKE, Director, Otological Research Unit of the Medical Research Council, London. For his investigations of the physiology and pathology of the internal ear and the mechanisms of hearing and equilibration.

JOHN EDWARD HARRIS, Professor of Zoology, University of Bristol. For his researches in several branches of experimental zoology.

WALTER KURT HAYMAN, Reader in Analysis, University of Exeter. For his contributions to the theory of functions of a complex variable.

NICHOLAS KEMMER, Tait Professor of Natural Philosophy, University of Edinburgh. For his pioneering work on the fundamental particles of physics, particulars on the meson and its role in determining forces within the atomic nucleus.

NICHOLAS KURTI, Lecturer and Demonstrator in Physics, University of Oxford, and Senior Research Fellow, Brasenose College. For his work on phenomena at very low temperatures, particularly in paramagnetism and nuclear alignment.

ROBERT GWYN MACFARLANE, Radcliffe Lecturer in Haematology, University of Oxford. For his studies in blood coagulation and their application for the treatment of haemophilia.

ROY MARKHAM, Principal Scientific Officer, Plant Virus Research Unit, Cambridge. For his studies on plant viruses and for his contributions to knowledge of nucleic acids.

JOHN WESLEY MITCHELL, Reader in Physics, University of Bristol. For his work on the action of light on crystals, particularly in photographic emulsions, and on the nature of the photographic latent image.

WILLIAM DRUMMOND MACDONALD PATON, Professor of Pharmacology,

Royal College of Surgeons, London. For his work on the relation between chemical structure and pharmacological action, and for the discovery of several important new drugs.

ALFRED BRIAN PIPPARD, Lecturer in Physics, University of Cambridge. For his work on the electrical properties of metals at radiofrequencies, and for his studies of the superconducting state.

HELEN KEMP PORTER, Principal Scientific Officer, Research Institute of Plant Physiology, Imperial College of Science and Technology, London. For her work on fructosans of leaves, on carbohydrate metabolism of fruits and cereals and for enzymological studies on polysaccharide syntheses in plants.

GEORGE SALT, Lecturer in Zoology, University of Cambridge. For his experimental and ecological researches on insects, especially on parasitic Hymenoptera.

CHARLES WILLIAM SHOPPEE, Professor of Chemistry, University College, Swansea. For his contributions to organic chemistry with special reference to the elucidation of problems of stereochemical relationships in the steriods.

FREDERICK WILLIAM SHOTTON, M.B.E., Professor of Geology, University of Birmingham. For his contributions in stratigraphy and particularly for his work on the Pleistocene deposits of the Midlands.

ERROL IVOR WHITE, Keeper of Geology, British Museum (Natural History), London. For his research on the earliest vertebrates and fossil fishes, particularly those from the Old Red Sandstone.

MAURICE VINCENT WILKES, Director, University Mathematical Laboratory, Cambridge. For his contribution to the design and construction of automatic calculating machines, and their application to the solution of scientific problems.

DENYS HAIGH WILKINSON, Lecturer in Physics, University of Cambridge. For his researches in nuclear physics, especially his investigation of the properties of the energy levels of light nuclei.

ARTHUR WORMALL, Professor of Chemistry and Biochemistry, St. Bartholomew's Hospital Medical College, London. Distinguished for his researches in biochemistry and for his pioneer work in the development of the use of isotopes in immunochemistry.

British Council's "Twenty-first"

The British Council has produced a special report to mark its twenty-first year, 1955. Science is well represented in the Council's activities; in 1954–5 one-third of the lecture tours it arranged abroad dealt with science or medicine. Three men of science sit on its executive committee, Sir Alfred Egerton, Dr. Alexander King and Dr. C. P. Snow (DISCOVERY's pre-war editor). A Science Committee (of which Mr. E. Bolton King is secretary) deals in more detail with scientific matters, and there is a panel of experts for agriculture, medicine, veterinary science and engineering. The Council's scientific activities are organised by its Science Group directed by Mr. Bolton King.

Since the end of the war the Council has arranged programmes for 35,726 overseas visitors (mainly professional people or technicians). A number of these have come under the United Nations or Colombo Plan schemes. The Drogheda Committee recommended more scholarships for scientific and technical students from Latin America, Africa and Asia. The Council can afford only 243 scholarships for study in this country. (The U.S.A. offers more than 4000.) Besides the scholarships the Council makes 160 awards to British, Commonwealth and foreign academic and research workers under the Commonwealth and Foreign University exchange schemes.

Project Vanguard

Hercules Powder Company has been selected as one of the two firms to carry out the design and development of the third and final stage rocket engine for Project Vanguard—the earth satellite programme.

Allegany Ballistics Laboratory, near Cumberland, Maryland, operated by Hercules for the U.S. Navy, and Grand Central Rocket Company, Redlands, California, were disclosed as participants in the earth satellite project by the U.S. Navy.

Design details for this third stage rocket have not been disclosed beyond the fact that it will be a new, solid-propellant rocket.

It was at Allegany Ballistics Laboratory that Hercules designed and developed booster rockets for the "Nike" and the "Terrier" guided anti-aircraft missiles and the "Honest John" free-flight, ground-to-ground artillery rocket.

It had earlier been disclosed that the earth satellite will be launched in numbers as part of the U.S. programme for participation in the International Geophysical Year (1957).

Counting on three stages of propulsion, the first two stages will use liquid propellants. With today's announcement, it was disclosed that solid propellants would provide the final powerful thrust, sending the man-made moon speeding around the earth in outer space.

A solid-propellant rocket was chosen for the third stage because of its simplicity. Such a rocket consists essentially of a combustible charge in a container, an igniter, and a nozzle for the escape of the gases. Liquid-fuelled rockets were chosen for the first and second stages because it is easier to guide that type of rocket.

Project Vanguard is the code name which has been assigned to the programme for a man-made instrumented satellite to be launched during the International Geophysical Year as a part of the United States scientific programme. Department of Defence participation is on a three-service basis, with Navy management under the Chief of Naval Research. In turn, the Naval Research Laboratory has the responsibility for implementing the technical programme, including the production of the three-stage rocket vehicle, and the launching and radio tracking of the satellite.

Expeditions to Peru and Borneo

The Chicago Natural History Museum is undertaking two important expeditions this year, to Peru and Borneo. Dr. Donald Collier, curator of South American archaeology and ethnology, will lead an expedition to uncover Peruvian cities that flourished before and during the Inca period in the Casma Valley, 200 miles north of Lima. The zoological expedition to Borneo will make representative collections of the island's reptiles, amphibians, and freshwater fishes. Dr. Robert F. Inger, curator of amphibians and reptiles, will be the leader.

Missiles May Safely Stray

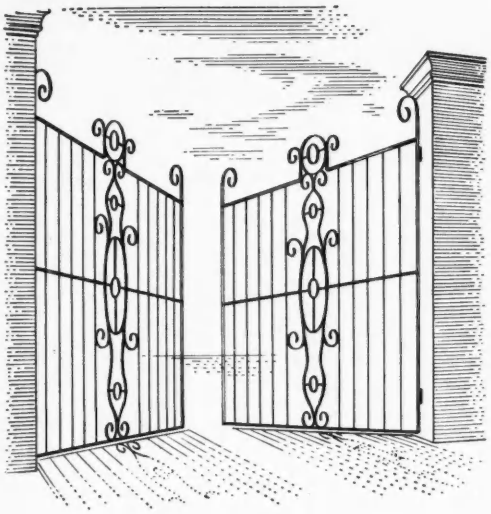
Twenty-one huge U.S. radar installations, forming a chain from Florida to the South Atlantic, went into service in April. These will provide a system for tracking guided missiles on test-firings at the U.S. Air Force's launching site at Cocoa, Florida. The Dynamics Corporation of America says that the equipment is so sensitive that any missile which strays even a little of course can be destroyed instantly, by the push of a button.

Night Sky in May

New moon occurs on May 10 at 13h 04m U.T., and full moon on May 24 at 15h 26m. The following conjunctions with the moon take place:

May				
03d 04h	Mars in conjunction with the moon		Mars	7°S.
11d 20h	Mercury	,,	Mercury	2°N.
13d 13h	Venus	,,	Venus	6°N.
17d 03h	Jupiter	,,	Jupiter	7°N.
24d 09h	Saturn	,,	Saturn	3°N.

Mercury sets at 21h 30m and 21h 05m at the beginning and middle of the month respectively, but towards the end of the month it is too close to the sun for observation. Its stellar magnitude is 0·3 at the beginning and 2 at the middle of the month, the decrease in brightness being due to the rapid diminution in the visible portion of its illumined disk from 0·450 to 0·098. It can be recognised in the western sky before sunset. Its close approach to the moon on May 11 has been pointed out earlier. *Venus* sets at 23h 45m, 23h 30m and 22h 35m on May 1, 15 and 31 respectively, and



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is conspicuous in the western sky, stellar magnitude 4·2. Viewed through a small telescope the crescent form of the planet is easily seen, and although the visible surface of the illuminated disk is 0·40 at the beginning of the month it is only 0·14 at the end of the month, so that the planet then looks (seen through a telescope) almost like a new moon. *Mars* rises in the early morning hours, at 2h, 1h 30m and 0h 50m on May 1, 15 and 31 respectively. It is very much fainter than Venus but increases a little in brightness during the month owing to its distance from the earth, decreasing from 98 to 77 million miles. Its close approach to the moon on May 3 has been pointed out. On May 3 it is very close to the star θ Capricorni, from which its eastward movement during the month is easily detected. *Jupiter* is visible throughout the night and sets in the early morning hours, at 2h 20m, 1h 30m and 0h 30m at the beginning, middle and end of the month respectively. It is impossible to mistake the planet, which is a very bright object in the constellation Leo. It is nearly south at 19h (7 p.m.) on May 1, but as sunset occurs soon after this the planet will not be visible till some time later, when it has crossed the meridian and is a little towards the west. *Saturn* rises at 21h, 20h and 18h 45m on May 1, 15 and 31 respectively, and does not set till the early morning hours. It lies in the constellation Scorpius which is rather low, but it is easily recognised with small optical aid, which will show its rings. A partial eclipse of the moon, magnitude 0·97, visible in Australasia and in South Africa towards the end of the month, takes place on May 24; the middle of the eclipse is at 15h 31·3m U.T.

Synthetic Glycerol

The first synthetic glycerol plant in Europe will be operating in 1957 at the Pernis Shell refinery near Rotterdam, Holland. Its cost will be about £2½ million. (Cf. article on glycerine from petroleum in DISCOVERY, 1950, p. 209.)

Molybdenum and Crops

The importance of molybdenum in nitrogen utilisation was the subject of a conference held recently at Johns Hopkins University, Baltimore. Dr. W. D. McElroy said a farmer can expect a yield of 3 tons of hay from an acre of lucerne—but not without 1/10 oz. of molybdenum in the soil. A. J. Anderson, the Australian agronomist who first demonstrated the value of molybdenum for crops, said it had worked a revolution on the pasturelands of his country. Clover yields have increased from nil to 3 or 4 tons an acre after using a few ounces of molybdenum. Where yield is not greater molybdenum-treated crops often contain more protein. Australian crops now being treated with molybdenum include flax, lettuce, turnips, cauliflower, cucumbers and even cereals.

Rabbits and Wool

Myxomatosis has added 70 million lb. (worth £A24 million) to the annual wool clip in Australia, it has been estimated by the Commonwealth's Bureau of Agricultural Economics. Sodium fluoroacetate is now being used by the Scientific and Industrial Research Organisation to poison Australia's remaining rabbits. Animals cannot taste this substance so do not become "educated" to it. In the U.S.A. it has been used on rats, mice and coyotes, as well as rabbits.

Promising New Antibiotic

The new "broad spectrum" antibiotic, *tetracycline* is fulfilling the promise of its early clinical trials. U.S. physicians report impressive results in eradicating the diverse bacteria responsible for acne and other skin diseases.

Britain's Atmospheric Pollution

There has been an increase in the atmospheric pollution of Britain from grit and dust, and a small decrease in pollution by smoke and oxides, over the last fifteen years, according to H.M.S.O.s *The Investigation of Atmospheric Pollution: A Report on Observations in the 10 years ended 31st March, 1954.* A million and a half individual measurements are summarized in the report.

N.P.L.'s Atomic Time Standard

The quartz clocks of the National Physical Laboratory are now checked against an atomic standard, and their accuracy has been increased as a result. They now keep time to 1 second in 30 years, and it is hoped to improve on this. This is the first time that quartz clocks have been calibrated with an atomic standard to an accuracy greater than that given by astronomical time.

One complete rotation of the earth gives the day and this is divided into a more convenient and shorter unit by the steady swinging of a pendulum or, in recent years, the more rapid vibrations of a ring of quartz. In practice, because astronomical measurements are relatively inaccurate, the results are averaged over quite long intervals. The working standards of time are the quartz clocks, which are adjusted periodically to keep in step with the earth. This procedure is no longer good enough for some scientific work, because the earth's rotation itself is found to fluctuate during the year. To overcome these fluctuations the observations must be averaged over still longer intervals of several years. The quartz clocks cannot be relied upon to keep uniform time for such long periods. So, although it is possible to know the average value of the unit of time with great accuracy, the value at any particular instant can only be known with a much smaller degree of accuracy. There is the added disadvantage that the results can only be calculated some years in arrears, when sufficient astronomical data have been accumulated.

The natural vibrations of the atom provide a more accurate standard and one that provides more rapid results. Not all atoms can be used, but the caesium atom is particularly suitable because of its unusual magnetic properties. It behaves like a tiny compass needle, which can, however, set either along the direction of a magnetic field or in exactly the opposite direction. The state it is in can be recognised by the direction in which it is deflected by a magnet. It is possible to produce a change from one state to the other by applying a magnetic field which is reversing its direction very rapidly, but only when the speed of alternation—or the frequency as it is called—corresponds exactly to a particular value which is a fundamental constant of the caesium atom. The reason for this is that a small but very definite amount of work must be done to change the atom from one state to the other. The frequency required is very high. So far, the most accurate measurements made give it as 9,192,631,830 cycles per second, but this may be revised slightly when the astronomers have digested all the measurements made during the last few months.

The pioneer work on atomic standards of time was carried out in the United States and a knoweldge of the experments made at Columbia University, the National Bureau of Standards and the Massachusetts Institute of Technology has been of great help in the developments at the National Physical Laboratory.

For many years the ring type of quartz clock invented at the National Physical Laboratory has been the best timekeeper in the world. It has now been geared to an atomic standard by the most accurate physical measurements that have ever been made, and still further advances have been made possible in this important branch of scientific work.

Bibliography of Colour Television

The Television Society has published a supplement bringing up to date its *Bibliography of Colour Television.* Copies of this supplement can be purchased from the Society at 164 Shaftesbury Avenue, London, W.C.2, price 1*s.* 6*d.* post free, and copies of the original *Bibliography* can be purchased for 2*s.* 6*d.* each.

Half a Million Copies Sold in U.S.S.R.

About fifty British scientific and technical works are annually published in the Soviet Union. Half a million copies altogether are involved per year. This year fifty-seven works will be brought out.

Continued on p. 220

Classified Advertisements

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ASSISTANTS (SCIENTIFIC): The Civil Service Commissioners invite applications for pensionable posts.

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Further particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S.59/56. Completed applications should be returned as soon as possible, and in any case not later than December 31, 1956.

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A TELE-COMMUNICATIONS ORGANISATION of international repute has vacancies in the London area for ELECTRICAL ENGINEERS on the development of a wide range of high frequency testing equipment associated with the design of telephone and television cables. Applicants should have a degree or equivalent, with practical experience in Electronics. Well equipped laboratory with access to all facilities of a large organisation. Permanent, pensionable position with commencing salary range £750 to £850. Write stating experience, qualifications, age, to Box No. D.1533, Aldridge Press Ltd., 27 Chancery Lane, London, W.C.2.

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APPLICATION FORMS for entrance to the 1956 Examination, returnable not later than June 1st, 1956, may be obtained from the General Secretary, The Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1. In applying for forms, applicants should state which parts of the examination they propose to take.

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FAR AND NEAR—continued

CERN in 1956

The 1956 budget for CERN (European Organisation for Nuclear Research) is 9 million Swiss francs more than for 1955: 34 million against 25 million. There is a heavy building programme this year; laboratories and workshops are being fitted in Meyrin and will be ready soon. By 1960 one hundred and ninety-seven million francs will probably have been spent (more than expected earlier), and the staff established at about 500 members.

A symposium on High Energy Physics is being arranged by CERN at Geneva from June 11–23.

Scientific Films

On Friday, March 16, a small audience saw the new Shell film *Power in Perspective*. This film was recorded by means of the new stereoscopic cine camera designed by Messrs. R. and N. Spottiswoode and made by Mr. C. Vinten. The film told briefly the history of power equipment and showed some beautiful colour sequences of small models and full-scale power machinery. Messrs. Spottiswoode have kindly agreed to describe their project, together with their co-operation with the National Research and Development Corporation in a forthcoming number of DISCOVERY.

Congress on High-speed Photography

The Third International Congress on High-Speed Photography will be held in London in September, 1956. It will be sponsored by the Department of Scientific and Industrial Research, and those wishing to participate should contact:

The Congress Secretariat, D.S.I.R., Charles House, 5–11 Regent Street, London, S.W.1. (Tel. Whitehall 9788, extension 56.)

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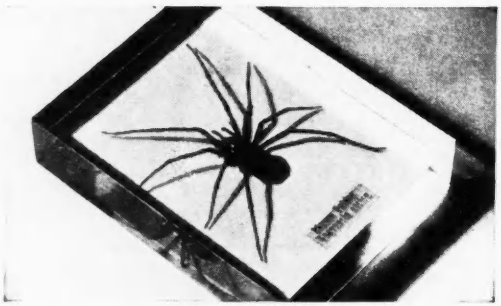
In the past five years afforestation has been carried out on 18,000 acres of the Astrakhan steppes. Trees are already 10 feet high in the Saratov-Astrakhan State forest-belt which stretches 120 miles down both banks of the Volga. 3,700 additional acres will be planted this year.

Errata

On p. 123 of the March issue the diagrams showing the formulae of cortisone contained two errors. Pregnenolene should have read Pregnenolone, and in the chemical structure of cortisone —O should have been added to the point 11 and —OH to the point 17.



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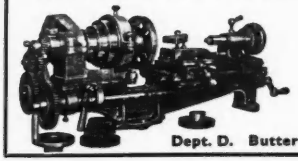

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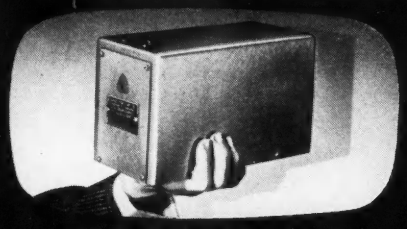

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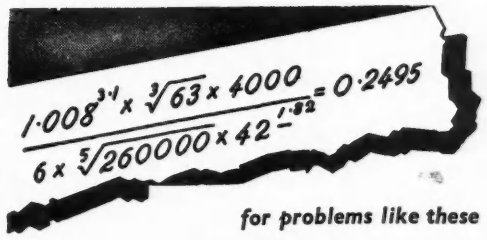

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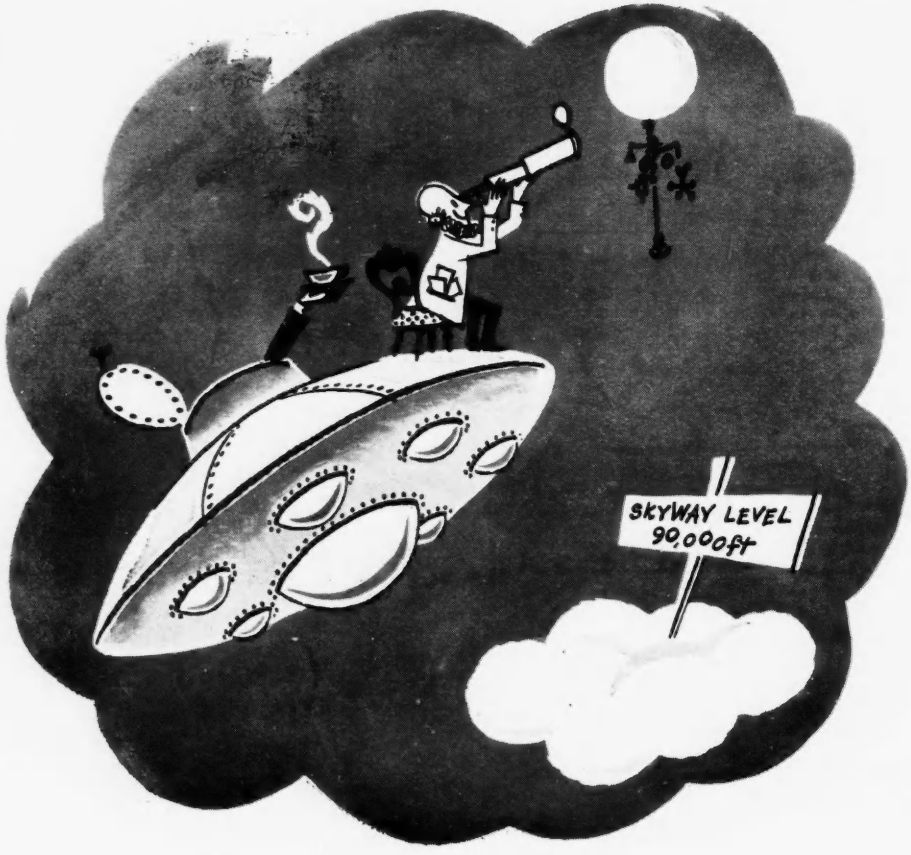

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